9 UPPER HUDSON RIVER BASIN

2 INDIAN LAKE STONE DAM

4B HAMILTON COUNTY
NEW YORK

3 INVENTORY NO. 155

5 PHASE I INSPECTION REPORT
1 NATIONAL DAM SAFETY PROGRAM

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NEW YORK DISTRICT CORPS OF ENGINEERS

SEPTEMBER 1978

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.
Indian Lake Stone Dam was judged to unsafe-non-emergency due to a seriously inadequate spillway.

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam Indian Lake Stone Dam NY155

State Located New York
County Located Hamilton
Stream Jessup River
Date of Inspection August 25, 1978

ASSESSMENT OF GENERAL CONDITIONS

The Indian Lake Dam is a masonry gravity dam with a section of earthfill with rubble masonry core wall. The overall length of the dam is 550 feet, the height of the dam is 47 feet. Since storage capacity of the dam exceeds 50,000 acre feet, the dam is in the Large Dam Category. The location of downstream residential lake front properties places the dam in the High Hazard Category. The drainage area of the dam is 121.7 square miles, the lake's surface area is about 8 square miles.

This Phase I investigation has determined that the dam is in need of further investigative work and possible structural modifications and repair work. The main area of concern is the spillway which has been found to be severely inadequate since it can pass only 45 percent of the Probable Maximum Flood (PMF). In addition, the dam could be topped by as much as 5 feet by the PMF, causing possible dam instability.

Using the Corps of Engineers screening criteria for initial review of spillway adequacy, it has been determined that the dam would be overtopped for all storms exceeding approximately 45% of the PMF. The spillway is, therefore, adjudged as being seriously inadequate and the dam is assessed as unsafe, non-emergency.

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

It is, therefore, recommended that within 2 months from the date of notification to the Governor of the State of New York, owner engage the services of a professional consultant to determine by more sophisticated methods and procedures the adequacy of the spillway. Within 12 months of the date of notification to the governor, appropriate remedial mitigating measures should have been completed. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

Other areas of concern have been noted which should receive attention:

1) The embankment has a large number of trees growing on it which probably should be removed. Seepage, along the toe of the earthen abutment, may be related to tree growth where seepage paths may have developed along root systems. If this is the case, it may be necessary to make a relatively comprehensive evaluation of alternatives to eliminate the seepage and improve the conditions of the embankment.

2) The undermining of the masonry buttresses at the outflow location should be repaired.

3) Through the dam seepage within the masonry sections should be significantly reduced.

4) The erosion in the spillway channel behind the weir should be repaired.

The work on all areas requiring remedial measures should be performed under the direction of a professional engineer. While these problem areas do not appear to be significant under normal flow conditions, they could be sources of dam instability during a severe flood event.

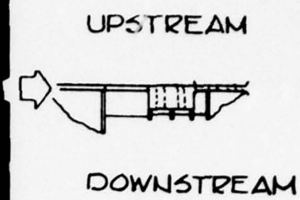
STATE OF NEW YORK
DALE ENGINEERING COMPANY, INCORPORATED
NO. 076
LICENSED PROFESSIONAL ENGINEER

Dale Engineering Company

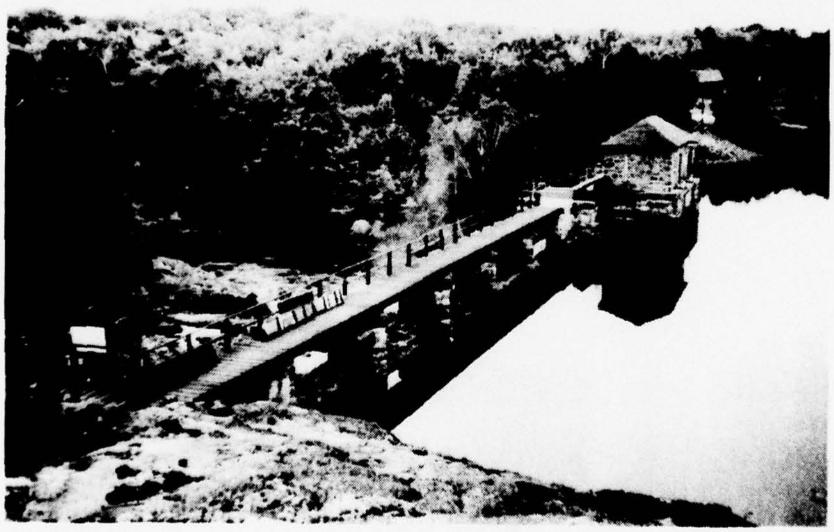
John B. Stetson, President

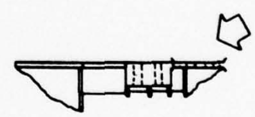
Approved By:
Date: 29 September 78

Col. Clark H. Benn
New York District Engineer



1. View across dam looking north. Road surface is on south dam embankment.





2. View across face of dam from north abutment.

3. View from below dam looking up towards spillway in right portion of picture. Spillway channel is carved out of rock.

4. View looking up towards spillway crest. Notice 2 flashboards are in place, the others are on top of bridge deck.

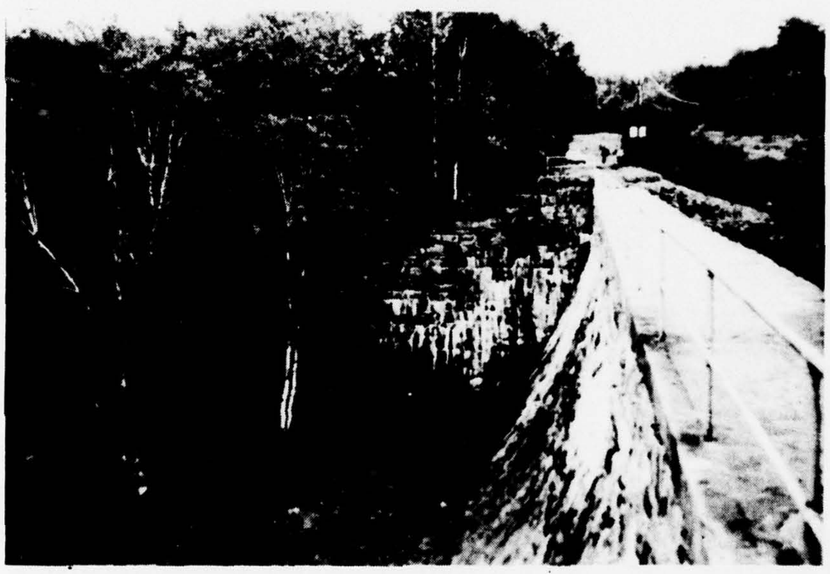
5. View looking down across downstream side of spillway which is benched out of rock so as to direct flows back toward main channel.

6. Closeup of lower spillway area shows erosion area next to training wall. A soil-cement type material has been placed in the encircled area but it too has eroded. The left center portion of the picture shows a log chute which is reported as not in use. The far left shows one of the two outflow discharge chambers.

7. A closeup of the encircled eroded spillway channel area shown in Picture #6.

8. Closeup of downstream spillway showing separation in masonry.

9. Another closeup of spillway facing showing limited seepages through masonry joints.



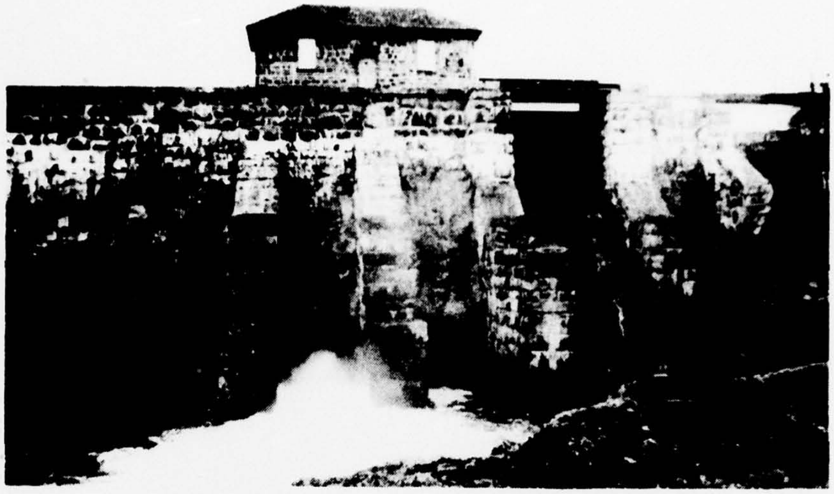
10. View looking south across downstream face of dam. The earthen section originates behind the masonry head wall. Whiteness in the photograph depicts calcium and iron oxide deposition.

11. Another view of the downstream wall section described in Picture #10.

12. Closeup of lower portion of wall showing extent of calcium deposition with limited seepage.

13. Upstream view of spillway.

14. Closeup along south abutment.



15. Picture of outlet chamber. The left chamber gate is 1 foot open. The right chamber gate is closed.

16. Closeup of left buttress wall shown in Picture #15. Notice end of wall is significantly undermined.

17. Detail of seepage from the ground surface area below headwall. Seepage is occurring over a sizable area. Both under-dam and abutment seepage is suspected.

18. Another picture of the seepage area; notice end of headwall. The dam earthen section on the downstream side of the embankment is heavily treed.

19. The upstream side of the earthen section is riprapped. This picture shows a sloughed area in the riprap in the center of the photograph.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM - INDIAN LAKE STONE DAM ID# - NY155

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

Authority for this report is provided by the National Dam Inspection Act, Public Law 92-367 of 1972. It has been prepared in accordance with a contract for professional services between Dale Engineering Company and The New York State Department of Environmental Conservation.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the Indian Lake Stone Dam and appurtenant structures, owned by the Indian Lake Corporation, and to determine if the dam constitutes a hazard to human life or property and to transmit findings to the State of New York.

This Phase I inspection report does not relieve an Owner or Operator of a dam of the legal duties, obligations or liabilities associated with the ownership or operation of the dam. In addition, due to the limited scope of services for these Phase I investigations, the investigators had to rely upon the data furnished to them. Therefore, this investigation is limited to visual inspection, review of data prepared by others, and simplified hydrologic, hydraulic and structural stability evaluations where appropriate. The investigators do not assume responsibility for defects or deficiencies in the dam or in the data provided.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

The Indian Lake Dam is a masonry gravity dam with a section of earthfill with rubble masonry core wall. The overall length of the dam is approximately 550 feet. The dam is approximately 47 feet high. The earthen core wall section forms the southerly abutment of the dam and is approximately 210 feet long. The center section is constructed of stone masonry and is approximately 170 feet long. The northerly abutment forms the major spillway section of the dam. This section is approximately 170 feet long. The earthen embankment section has a top width of approximately 15 feet. Slopes on the downstream side are 2 horizontal to 1 vertical and upstream slopes are 2-1/2 horizontal to 1 vertical. The upstream side of the earthen embankment is covered with a layer of riprap from the top of the dam to original ground at the bottom of the reservoir. The center section of the dam has a top width of approximately 7 feet 8 inches with a base width of 33 feet. This section is founded on rock and houses the sluice gates and gate house which control flow from the impoundment. The spillway section consists of seven openings which form the spillway for the dam. The southerly most spillway opening was formerly used as a log-way to pass logs from the impoundment into the receiving stream. The spillway section is also founded on solid rock. The receiving stream immediately downstream from the spillway section is formed in rock and shows no sign of erosion.

b. Location

The Indian Lake Dam is located in the Town of Indian Lake, Hamilton County, New York.

c. Size Classification

The maximum height of the dam is approximately 47 feet. Although no data is available regarding the storage capacity of the impoundment, it is estimated that the storage capacity is approximately 67,000 acre feet which is in excess of 50,000 acre feet. Therefore, the dam is in the Large Size Category as defined by The Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification

There are many residential lake front properties situated downstream from the dam on the banks of the receiving stream. A New York State Highway, Route 28, also crosses the receiving stream downstream from the dam. Therefore, the dam is in the High Hazard Category as defined by The Recommended Guidelines for Safety Inspection of Dams.

e. Ownership

The dam is owned by the Indian River Company, 126 State Street, Albany, New York 12207.

f. Purpose of Dam

The main purpose for the dam is to maintain a level in Indian Lake for recreational purposes. The dam is also used to control flows in the receiving stream for hyrdo-power facilities downstream in the Hudson River.

g. Design and Construction History

The Indian Lake Dam was constructed in 1898. The contractor for the construction was Macdonough, Cunningham and Howland. No definite record is available to determine the designer of the dam. In 1930, new trash racks were installed at the sluiceway openings. The entire upstream face of the dam and entrance well were also gunited from elevation 1617 to elevation 1630. The buttress walls at the outlet were also gunited to a height of about 4 feet above the water at this time.

h. Normal Operational Procedures

Flows from the Indian Lake Dam are presently maintained to provide adequate flow in the receiving stream. During the winter months, the elevation of the impoundment is maintained approximately 10 feet below the top of the spillway to allow for capacity during spring thaws. There is continual observation of the dam and its condition by a caretaker who resides in a home immediately adjacent to the dam.

1.3 PERTINENT DATA

a. Drainage Area

The drainage area of Indian Lake Dam is 121.7 square miles.

b. Discharge at Dam Site

No discharge records are available for this site.

Computed discharges:

Ungated spillway, top of dam	6223 cfs
Ungated spillway, design flood	29254 cfs (PMF)
	8150 cfs (1/2 PMF)

c. Elevation (feet above MSL)

Top of dam	1657
Maximum pool - design discharge	1658 (1/2 PMF)
	1662 (PMF)
Spillway crest	1650
Stream bed at centerline of dam	1610

d. Reservoir

Length of normal pool	67300 feet

e. Storage

Normal (spillway crest)	67000 acre feet (rough estimate)
Surcharge (normal pool to top of dam)	30100 acre feet

f. Reservoir Area

Spillway pool	4446 acre

g. <u>Dam</u>

Type - Masonry stone dam with an earthen embankment section.
Length - 550 feet.
Height - 47 feet.
Freeboard between normal reservoir and top of dam - 7 feet.
Top width - Earthen: 15 feet; masonry: 7 feet.
Side slopes - Earthen: 2 on 1 downstream; 2-1/2 on 1 upstream
Masonry: 1 on 1 downstream; vertical upstream.
Zoning - Not known.
Impervious Core - Masonry core wall in earthen structure.
Grout Curtain - None.

h. <u>Spillway</u>

Type - Weir.
Length - 105 feet.
Crest Elevation - 1650 (MSL).
Gates - None. Former logway gate is inoperative. Hoisting mechanism has been removed.
U/S Channel - None.
D/S Channel - Natural stream channel.

i. <u>Regulating Outlets</u>

2 - 5-foot diameter steel pipes with gate valves.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The information available for review of the Indian Lake Dam included:

1) One sheet of plan by International Paper Company included in this report as Figure 2.

2.2 CONSTRUCTION

No information was available regarding the construction of the dam.

2.3 OPERATION

See Section 4.

2.4 EVALUATION

The data reviewed indicates that the dam has been maintained throughout the years. The present condition of the dam indicates that additional research for data on the structure is not required in order to complete this Phase I investigation.

SECTION 3 - VISUAL INSPECTION

3.1 SUMMARY

a. General

The Indian Lake Dam was inspected on August 25, 1978. The dam presently functions to maintain water elevation in Indian Lake for recreational purposes and to augment flow in the receiving stream. The inspection crew was accompanied on the inspection by Leo Bernier of the International Paper Company from Corinth, New York. International Paper Company provides maintenance and observation of the dam for the owners, the Indian Lake Company.

b. Dam

The dam and spillway system visually conforms to the plans as shown in Figure 2. The south end of the dam consists of an earthfill section with rubble masonry core wall. This earthfill section is at an elevation two feet above the remainder of the dam. The earthfill on the downstream slope is covered with trees that have been long established on the slope. The upstream slope of the earthfill section is riprapped to the bottom of the slope in the reservoir. There is some minor displacement of riprap near the point where the earthfill section joins the masonry dam. Some seepage was noted along the downstream toe of the earthfill section near the south abutment and near the place where it abuts the masonry section. The seepage would not be described as severe and was observed at a time after a substantial rainfall.

The downstream face of the masonry section shows signs of minor seepage and some deterioration of the mortar joints. A similar condition was observed on the masonry face of the south abutment where the masonry section joins the earthfill section. Seepage through the joints leaves rust colored deposits that would suggest iron oxide. The toe of the masonry section has recently been cleared of trees and brush and showed no signs of seepage.

Channels for the outlet pipes are formed by three buttresses. These buttresses are located just opposite the gate house. At the time of the inspection, the southerly gate was open approximately one foot. The northerly gate was closed. Substantial flow was coming through the southerly channel. The toes of these buttresses were eroded so that a space was left between the end of the buttress and the supporting rock in the stream channel. This space was approximately one foot high and extended approximately three feet toward the dam from the toe of the buttress.

c. Spillway

A series of spillway openings are located just north of the masonry section. The southerly most opening was formerly used as a logway. This opening is now closed with a steel stop-plank and the hoisting mechanism to operate the gate has been removed from the structure rendering it inoperative. Minor seepage occurs around the steel stop-plank. At the time of the inspection, the stop-planks had been removed from the three northerly weir openings. These stop-planks were stored on the walkway which crosses the spillway. Stop-planks were in place in the remaining weir openings. There is minor seepage through the masonry in the spillway area. The spillway is founded on original rock. Some erosion of the rock has taken place near the south end of the spillway. An area appears to have been filled with either concrete or soil cement and this repair of the crevice has been again eroded leaving a void in the rock surface. The spillway crest is formed in granite and is generally in good condition.

d. Appurtenant Structures

The walkway across the spillway and the dam has recently been reconstructed and is in excellent condition. Inspection of the gate house indicates that the control gates are electrically operated and are in operating condition at the present time. There are four sluice gates on the exterior face of the gate house which conduct flow to the discharge pipe. At the time of the inspection, all of these gates were in a full-open position.

e. Reservoir Area

The reservoir area is generally heavily forested and does not contribute significant amounts of sediment to the impoundment. Local inquiry indicated that there were no known areas where unstable banks might occur.

f. Downstream Channel

The area downstream from the dam is a rock channel and in good condition.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operation of the gates was not observed by the inspection team. The dam and reservoir is owned by the Indian Lake Company who is assisted in its operation by International Paper Company. The Indian Lake Company owns a residential property immediately adjacent to the dam. This house is occupied by the Indian Lake postmaster who also serves as part-time attendant for the dam. Control gates in the gate house are manipulated to reduce the water level during the winter months in order to accommodate spring runoffs. During the remainder of the year, flow is metered to the receiving stream in order to maintain adequate flows for both Niagara Mohawk and International Paper Company.

4.2 MAINTENANCE OF DAM

Inspection indicates the dam has been recently maintained. Discussions with the representative from International Paper Company indicate that maintenance has been performed over the years by International Paper Company.

SECTION 5 - HYDROLOGY AND HYDRAULICS

5.1 EVALUATION OF FEATURES

The Indian Lake Stone Dam lies at the northern end of Indian Lake. The drainage area of the lake is 121.7 square miles as planimetered from U.S.G.S. quad sheets, the lake is 12.75 miles long with a surface area of 7.93 square miles. The volume of the impoundment is purely a function of the natural watershed. For the dam's location, no historical information was available on the occurrence of flood events. Also, no information relevant to the design of the dam was available for this investigation. Therefore, this analysis is based on information obtained from the field inspection, the plans included herein, U.S.G.S. quadrangle mapping and other sources of information and references listed in Appendix E. The hydrologic and hydraulic analysis is provided in Appendix C.

The purpose of this investigation is to evaluate the dam and spillway with respect to their flood control potential and adequacy. This has been assessed through the evaluation of the Probable Maximum Flood (PMF) for the watershed and the subsequent routing of the flood through the reservoir and the dam's spillway system. The PMF event is that hypothetical flow induced by the most critical combination of precipitation, minimum infiltration loss and concentration runoff of a specific location that is considered reasonably possible for a particular drainage area. Since this dam is in the Large Category and is a High Hazard, the guidelines criteria (Ref. 1) require that the dam be capable of passing the Probable Maximum Flood.

The hydrologic analysis was performed using the unit hydrograph method to develop the flood hydrograph. Due to the limited scope of this Phase I investigation, certain assumptions, based in experience, were used in this analysis and in the determination of the dam's spillway capacity to pass the PMF. This was done with the concept, that if the dam was unable to satisfy this criteria, further refined hydrologic investigations would be required. In preparing the unit hydrograph, both Clark and Snyder coefficients were estimated. For the Clark Method, values of $Tc = 9.09$ and $R = 9.09$ were computed. The values of $R/(Tc + R)$ was estimated at 0.50 for the analysis. For the Snyder Method, values of $Tp = 11.49$ and $Cp = 0.625$ were computed. The two unit hydrographs were developed from these parameters as well as two sets of PMF hydrographs. The resulting two PMF hydrographs developed from the two methods were then compared and evaluated. The PMF hydrograph was determined using the Probable Maximum Precipitation rainfall data obtained in Hydrometeorological Report No. 33. An index rainfall of 17.5 inches for 200 square miles for a period of 24 hours was used in the analysis. Base flow for the basin was assumed to be 2 cubic feet per second per square mile, while loss rates were set at 1.0 inches initial abstraction and 0.1 inches/ hour continuous loss rate. The loss rate functions for the basin yielded 14.71 inches of runoff from 18.09 inches of precipitation. The flood surcharge storage effect from the lake was assumed to vary linearily with the spillway elevation surface area (the lake's spillway elevation surface area times the surcharge depth yeilds storage - See Sheet C-4). Only the service spillway was evaluated to pass the PMF hydrograph. Other gates were assumed to be either closed or not functionable. Although there is a dam attendant at the site, he is not assigned at the dam on a full-time basis. In addition, the gates operate from a control house in the center of the dam and they may not be accessible during a severe flood event. Finally, the gates do not have significant discharge capability relative to the PMF. The spillway capacity (up to the top of the dam elevation) considering the service spillway only is estimated at 6223 cfs. This was based on an effective spillway length of 105 feet with a discharge coefficient of 3.2. The earthen and masonry top of the dam section were assumed to be the same elevation (elevation 1657). The elevation of the lake was assumed to be at the spillway crest (elevation 1650) at the initiation of the flood event.

The U. S. Army Corps of Engineers, Hydrologic Engineering Center's Computer Program HEC-1 using the Modified Puls Method for flood routing was used to evaluate the dam and spillway capacity. The results of this analysis are shown below:

HEC-1 PMF ANALYSIS

	CLARK'S METHOD		SNYDER'S METHOD	
Percent Of PMF	Run-off Discharge (CFS)	Routed Discharge (CFS)	Run-off Discharge (CFS)	Routed Discharge (CFS)
10	7204	838	6030	818
20	14408	2163	12059	2092
30	21611	3750	18089	3606
40	28815	5698	24119	5390
50	36019	8150	30148	7747
60	43223	11909	36178	11057
70	50426	15712	42208	14659
80	57630	20182	48237	18081
100	72038	29254	60297	26982

Based on the above results, the spillway is capable of passing only 45% of the PMF. Since this value is less than 50% according to the guidelines, the spillway is deemed to be severely inadequate. This analysis indicates the dam would be overtopped by approximately 5 feet with the PMF. A more indepth study in regards to the evaluation of the spillway capacity is therefore recommended. If futher analysis confirms these Phase I investigation results that the spillway is inadequate, it is then recommended that the owner modify the structure to provide for additional spillway capacity.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations And Data Review

The dam, consisting generally of three distinct structural sections along its length (an earthen embankment southern section, a non-overflow masonry center section, and an uncontrolled spillway masonry northern section), shows no evidence of misalignment, settlement or other signs of movement which would indicate a condition of structural distress. However, the downstream face of the non-overflow masonry center segment shows considerable evidence that seepage, albeit apparently minor, has been on-going for a period of time through much of this section. Masonry buttresses on the dam's downstream side (at the location of sluice tunnels and a logway), near the location where the non-overflow and spillway sections of the dam join, retain stability but undermining (loss of masonry) has begun at the downstream extremity. The logway is presently gated, but leakage does occur and erosion of a concrete surface provided for the downstream flow channel is on-going. However, the incidence has not yet had any effect of structural significance.

The dam's southerly earthen section gives the appearance of being in good structural condition, with no evidence of settlement, sloughing or significant erosion. Surface water was noted on the date of inspection near the embankment's downstream toe in the vicinity of the masonry abutment where the earthen and masonry sections join; this condition may represent seepage through the dam. Seepage also occurs through the exposed face of this abutment. The upstream slope of the embankment section is provided with riprap, observed to be in generally good condition. The downstream slope has developed vegetation which includes some relatively tall trees.

b. Geology and Seismic Stability

The general area encompassing the reservoir site is underlain by Precambrian metamorphic rocks of the Lake Durant Formation. In the area of the dam, the rocks are, for the most part, gneisses with subordinate amounts of quartzite.

Contact of the foundation bed under the spillway and the gate house is with bedrock. Although the foundation bed beneath the remainder of the dam cannot be observed, the June 28, 1920 (New York State Conservation Commission) dam report mentions "such foundation bed is rock." Diagrams for that report indicate that the right (south) abutment contact is earth. Drawings (apparently the dam's original design/construction drawings, but dated as being traced October 9, 1959) show the core wall on the right on "hard pan" and the right abutment in contact with rock. Thus, there is uncertainty as to the contact of the right abutment. The base contact is probably on rock with the wall contact probably with earth.

Indian Lake follows a major fault line. According to Miller (1917, P. 45, Ref. 18), the Indian Lake fault "ranks as the longest continuous line of fracture yet located in the Adirondack region." Outcrops along the shore of Indian Lake have well-developed fracture patterns. Gerahty (1978 Ref. 17) states, "The best exposure for observing a well-developed fracture pattern and slickensides is located at the dam at the northern end of Indian Lake." Slickensides and crushed zones, also present, are excellent indications of previous faulting activity.

The New York State Geologic Map (1970) shows many large faults in this general area. Additional numerous lineaments of unknown origin are shown on the New York State Geological Survey Preliminary Brittle Structures Map (1977). The geologic structures map shown in this report is after Gerahty (1978) who has done the most recent analysis of this region.

Although only one earthquake of any significance (IV on the Modified Mercalli Scale) has occurred in this area, about 22 miles to the northeast in 1913, numerous low intensity earthquakes have been recorded. In 1974 alone, 102 events were recorded in the Blue Mountain Lake region, 15 miles to the northwest of the dam. This region is located in seismic zone 2 and thus a potential of intensity VI-VII (Modified Mercalli Scale) is possible.

c. <u>Data Review and Stability Evaluation</u>

An as-built drawing indicating details of the dam as constructed in 1898 is available for review. This drawing shows typical masonry and embankment sections, and indicates the masonry segment to be founded on the areas "solid rock," presumed to be bedrock similar to that observed at the dam's northerly abutment and below the downstream toe. The earth embankment section is constructed with a masonry core wall. The as-built drawings are unclear about the core wall extending to bedrock; it does appear that the earthen materials forming the shell portions of the embankment section bear on firm earth (hardpan), not bedrock.

Because of the variable depth to rock along the longitudinal axis of the dam, it appears that the highest masonry section is located near center length, at a non-overflow section. Stability analyses have been performed (Appendix D) for this section, bearing on rock, assuming the condition of

(i) a lake level at spillway elevation, with ice;
(ii) a lake level which breaches the dam by one foot.

Part of the non-overflow masonry section has had soil embankment placed behind it; this earth material is the result of the sloped-runout for the embankment section of the dam, from the location where the embankment and non-overflow sections meet. The slope of the earth material behind the masonry section is 2-1/2 to 1 (H to V) parallel to the longitudinal axis of the dam and, simultaneously, 2 to 1 perpendicular to the dam's longitudinal axis. Simplifying assumptions felt to be conservative have been utilized to evaluate the effect where soil embankment material acts behind the masonry section.

Properties of the earth materials in the dam area and the dam's masonry are not indicated on the drawings reviewed. Actual properties of the dam materials, the site's foundation material, and the groundwater conditions in the area have not been determined; where data necessary for stability analysis was lacking, assumptions felt to be conservative have been applied.

The analysis performed indicated structural stability against overturning, and sliding is maintained for the static loading conditions assumed, as summarized in the table below:

Results of Stability Computations

	Loading Conditions	Factory of Safety Overturning	Factory of Safety Sliding
(1)	Water level and ice at spillway elevation, upstream and downstream ground surface correspond to the base of the dam section, downstream water surface at the base of the dam, uplift water pressures result from simple hydrostatic conditions and act on the full base area of the dam section, no seismic forces acting, no earth embankment behind the section.	1.35±	1.7+
(2)	Water level tops non-overflow section by one foot, no ice, other conditions as indicated in (1) above.	1.1±	1.2+
(3)	Conditions as for (1) above, except lateral pressure from soil embankment act against the upstream face.	1.3±	1.5±
(4)	Conditions as for (2) above, except lateral pressure from soil embankment act against the upstream face.	1.04	1.1+

The computed factors of safety represent the ratio of moments/forces resisting failure movements to those acting to cause failure; stability or a no-failure condition is indicated when the ratio of greater than unity. The hydrologic analysis indicates the dam could be topped by PMF by as much as 5 feet. Although this loading condition has not been evaluated, it is suspected that instability would result under this condition.

The prediction of uplift pressures acting on the base of a masonry dam founded on rock represents an area of some uncertainty to the engineering profession, unless field measurements have been obtained to provide applicable data. The analysis uplift force was based on a full headwater hydrostatic pressure acting on the dam's upstream corner, and a tailwater hydrostatic pressure of zero (corresponding to a tailwater elevation equal to the dam's base and downstream ground surface elevation). Uplift pressures were assumed to vary linearily between the dam's upstream and downstream corners, and act upon 100 percent of the dam base.

The computed factors of safety indicate the masonry sections of the dam retain stability for the various conditions of loading assumed. Low factors of safety are implied for the locations where lateral pressures from a high height of earth embankment acts behind the section. The computed factor of safety shown in the tabulation could be lower than the actual factor of safety for the area. The section of masonry dam having the greatest height of earth embankment behind it is adjacent to the location where the headwall serving to abut the masonry and earthern sections of the dam meet; the masonry headwall should serve to provide a buttressing effect which improves the resistance to movement and the stability of the section.

Though seepage is on-going through the face of the masonry section at various locations, the condition does not appear to have a significant deteriorating effect. When the lake is lowered (reportedly a procedure followed in winter periods to provide storage for runoffs generated in the spring), the exposed upstream face can be examined for signs of deterioration and to provide an indication of possible need for repair which can extend to also providing repair of the areas where the downstream face implies seepage. As a minimum, frequent inspections should be made to detect changes in the seepage pattern which would indicate a need for attention.

The earthen embankment section is stable but also shows indication of probable seepage. As for the masonry section, the embankment section should be inspected at frequent intervals to detect a change in conditions which indicate the need for corrective measures. At present, the downstream face of the embankment area has a number of trees growing on it. Seepage may be related to tree growth where seepage paths may have developed along root systems. If this is the case, it may be necessary to make a relatively comprehensive evaluation of alternatives to eliminate seepage and improve the condition of the embankment. Trees should also be removed to prevent the danger of loss of embankment which would occur if uprooting in a high velocity wind storm occurred. The clearing of brush from the embankment area will also permit an inspector to better detect conditions of possible embankment seepage.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

On the basis of the Phase I visual examination and analysis, it has been concluded that the dam is in need of further evaluation and investigation since the spillway has been found to be seriously inadequate. The hydrologic analysis indicates that the spillway will not pass the 1/2 Probable Maximum Flood without overtopping the dam. The spillway capacity is 6223 cfs without the flashboards. This spillway capacity relates to 45 percent of the Probable Maximum Flood.

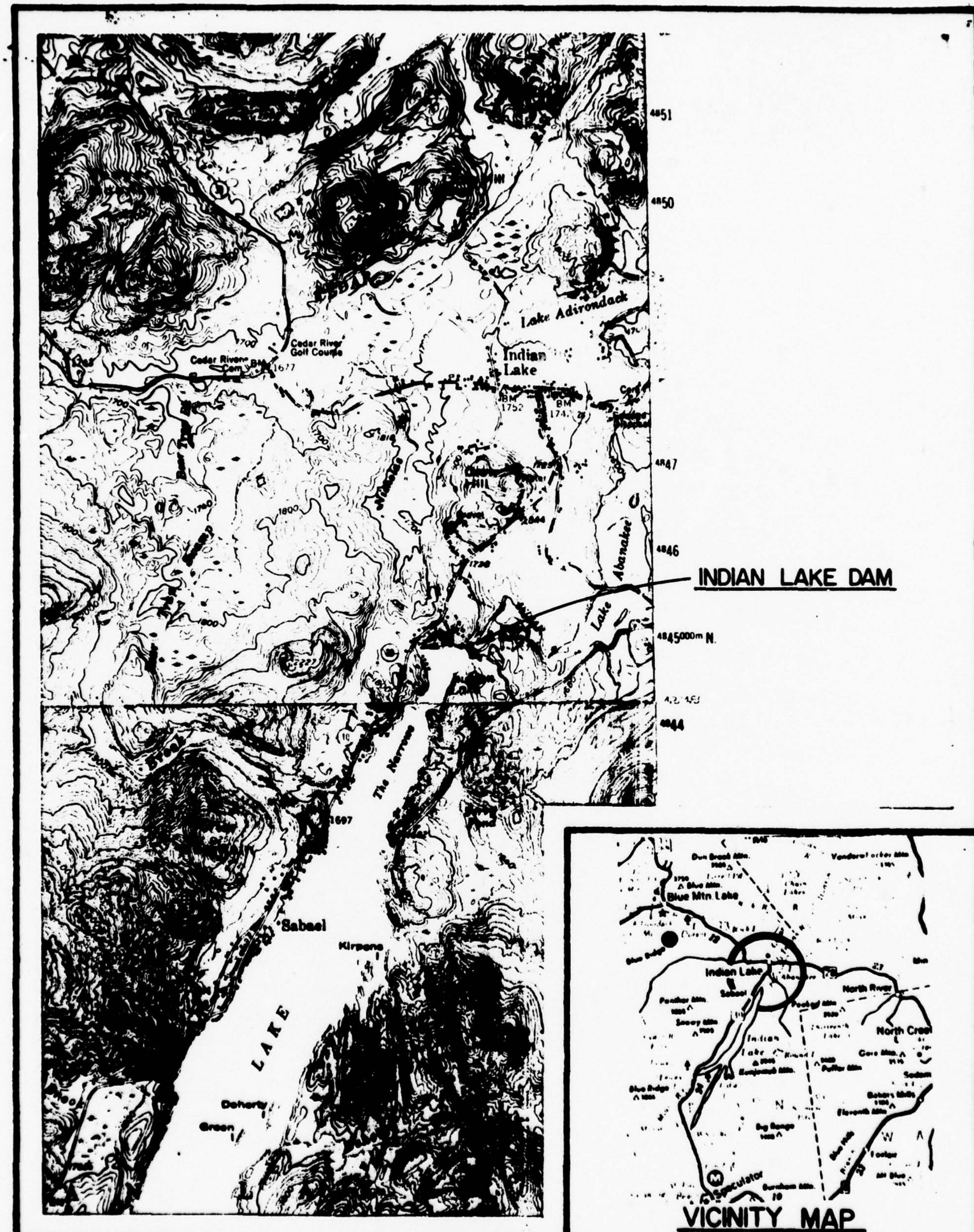
A number of additional items observed during the inspection are of concern and need attention. The earthern downstream embankment section is covered with trees that have been long established on the slope. A limited amount of seepage was noted along the downstream toe of the earthfill section near the south abutment and near the point where it abuts the masonry section. The downstream face of the masonry center segment shows considerable evidence that seepage, apparently minor, has been ongoing for a period of time. Masonry buttresses on the dam's downstream side retain stability but undermining has begun at the downstream extremity. There is minor seepage through the masonry in the spillway area. Some erosion of rock has taken place near the south end of the spillway. An area in the spillway channel appears to have been filled with either concrete or soil cement and this repair of the crevice has again eroded leaving a void in the rock surface.

The stability analysis performed indicates structural stability against overturning and sliding is maintained for the static loading conditions assumed. The hydrologic analysis indicates that the dam may be topped by as much as 5 feet by the PMF. Although an analysis has not been performed under this loading condition, it is suspected that instability would result under this condition.

7.2 REMEDIAL MEASURES

The spillway's capacity is seriously inadequte. It is recommended that the owner take immediate action to provide round-the-clock surveillance during periods of unusually high runoff and have a contingency plan in the event of overtopping. There is a small lake community directly below the dam. The flashboards should be removed from the spillway immediately. Through the dam seepage within the masonry sections should be significantly reduced. The undermining of the buttresses at the outlet area should be repaired. The erosion in the spillway channel behind the weir should be repaired. This work should be performed under the direction of a professional engineer.

The embankment has a large number of trees growing on it which should probably be removed. Seepage may be related to tree growth where seepage paths may have developed along root systems. If this is the case, it may be necessary to make a relatively comprehensive evaluation of alternatives to eliminate the seepage and improve the condition of the embankment.



LOCATION PLAN

FIGURE 1

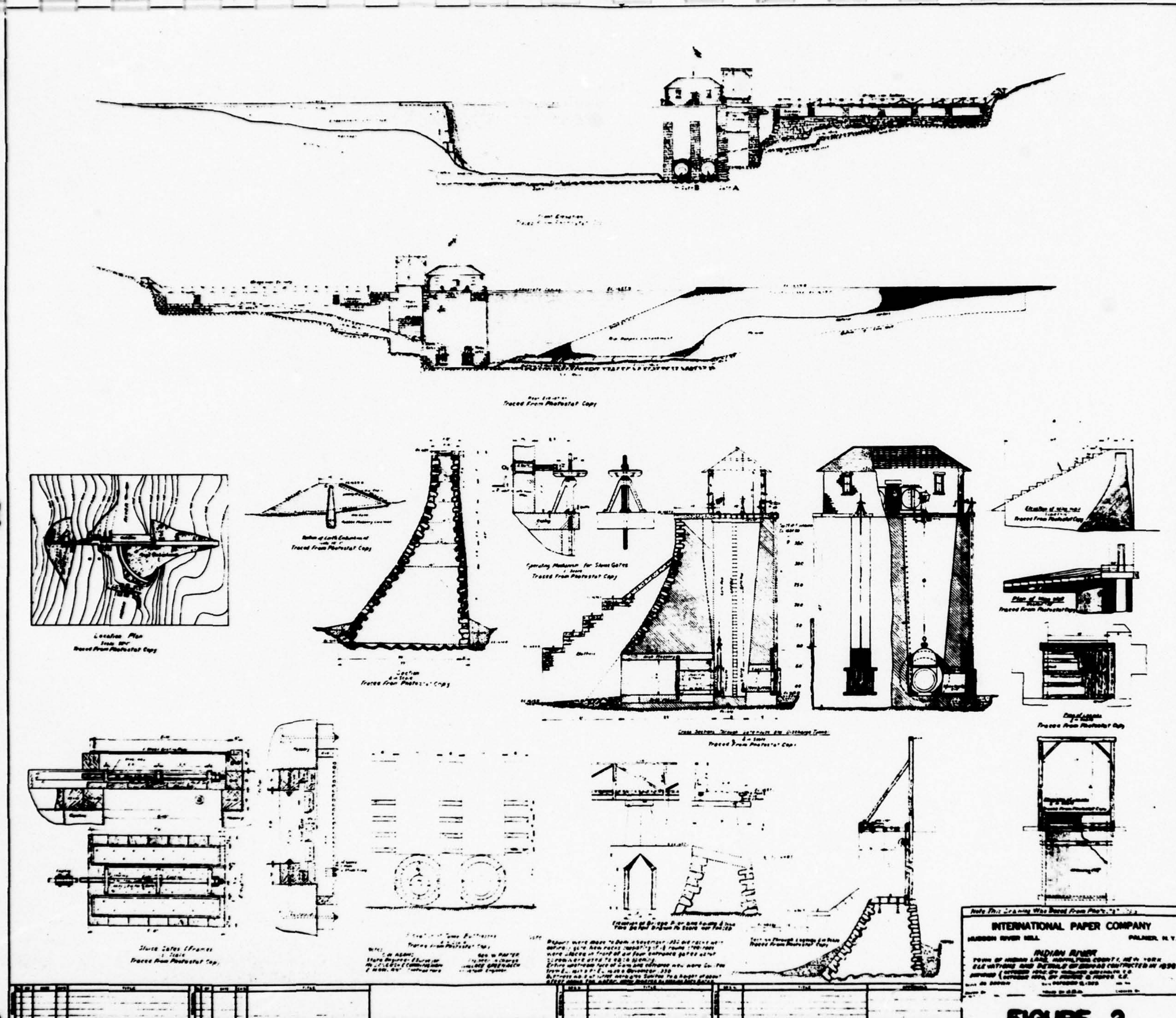
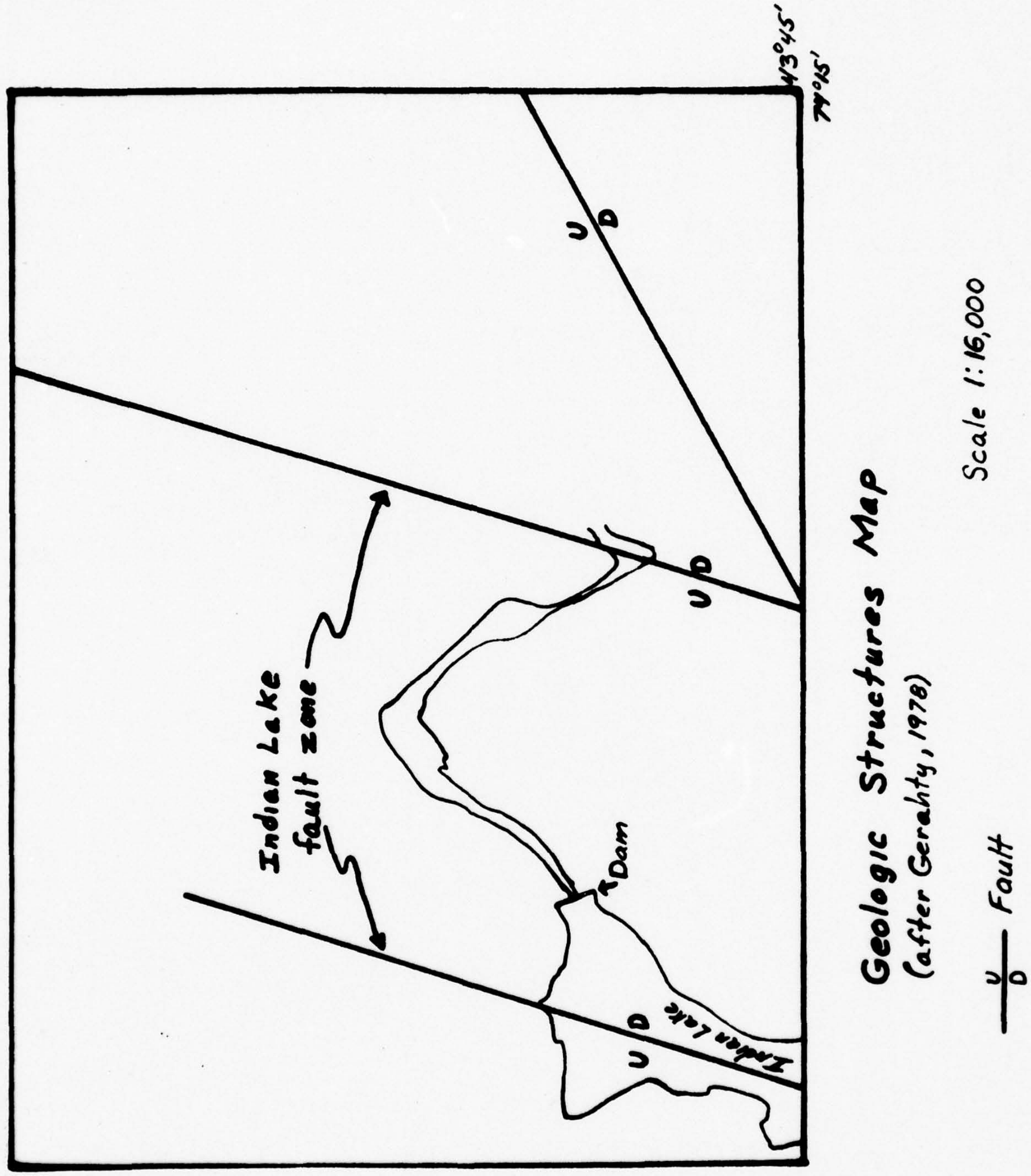

Traced From Photostat Copy
Location Plan
Traced From Photostat Copy
Sluice Gates & Frames
Traced From Photostat Copy
Cross Section Through Gatehouse and Discharge Tunnel
Traced From Photostat Copy
INTERNATIONAL PAPER COMPANY
HUDSON RIVER MILL
PALMER, N.Y.
INDIAN RIVER

FIGURE 2



GEOLOGIC MAP

FIGURE 3

APPENDIX A

FIELD INSPECTION REPORT

CHECK LIST
VISUAL INSPECTION

PHASE 1

Name Dam INDIAN LAKE DAM County HAMILTON State NEW YORK ID # 155

Type of Dam MASONRY Hazard Category HIGH

Date(s) Inspection AUGUST 25, 1978 Weather CLOUDY Temperature 70° F.

Pool Elevation at Time of Inspection 1649.5 ± M.S.L. Tailwater at Time of Inspection ----

Inspection Personnel:

N. F. DUNLEVY DALE ENGINEERING COMPANY

F. W. BYSZEWSKI DALE ENGINEERING COMPANY

H. MUSKATT DALE ENGINEERING COMPANY

F. D. MC CARTHY DALE ENGINEERING COMPANY

LEO BERNIER, PLANT ENGR., INTERNATIONAL PAPER CO., CORINTH, N.Y.

N. F. DUNLEVY Recorder

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	There is a slight seepage between masonry joints in northern spillway area. The south abutment wing wall has some seepage as well as limited seepage on downstream wall including some calcifications.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	South abutment wall has seepage with iron oxide deposition. Below and behind the south abutment, considerable wetness (seepage is suspected) was noticed.	
DRAINS	None observed.	
WATER PASSAGES	A log passage closed with steel planks leaks.	
FOUNDATION	See spillway section and outlet section for problem areas. The general dam section did not show any problems.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES (Masonry surfaces only)	Limited seepage, calcification at mortar joints.	Dam could use some pointing of mortared joints.
STRUCTURAL CRACKING	None observed.	
VERTICAL & HORIZONTAL ALIGNMENT	Good condition.	
MONOLITH JOINTS	None.	
CONSTRUCTION JOINTS	None observed.	
STAFF GAGE OF RECORDER	None.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Slopes overgrown with trees. No significant erosion or sloughing.	Remove trees.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Good.	
RIPRAP FAILURES	Minor riprap failure near junction with masonry section of dam.	Repair riprap.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	N/A	
ANY NOTICEABLE SEEPAGE	Minor seepage evident at south abutment.	
STAFF GAGE AND RECORDER	None.	
DRAINS	None.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR (Masonry Weirs only)	Generally in fair condition. Some seepage noted with joints opened up to one inch.	Spillway seepage needs repair.
APPROACH CHANNEL	No separate approach channel. Reservoir discharges directly over masonry wier. Reservoir is shallow in area near wier.	
DISCHARGE CHANNEL	Cut rock surface. Benched down to stream. Significant erosion at south end of spillway. Previously filled with soil, cement has severely eroded.	Eroded spillway section next to dam should be repaired.
BRIDGE AND PIERS	Masonry piers for walkway in good condition. Walkway refurbished this year.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	None.	
APPROACH CHANNEL	None.	
DISCHARGE CHANNEL	None.	
BRIDGE AND PIERS	None.	
GATES AND OPERATION EQUIPMENT	One gated opening at spillway elevation. Formerly used as a logway. Gate is inoperative. Hoisting equipment has been removed.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT (Masonry only)	No observation.	Outlet chamber built into dam.
INTAKE STRUCTURE	Intake structure is built into front of dam. Gate was opened 5 ft. at the time of inspection.	
OUTLET STRUCTURE	Built into dam. Outlet area has buttresses which are severely undermined. Visually, the dam appears stable.	Stability of dam due to undermining and stability of outlet chamber should be investigated.
OUTLET CHANNEL	A stilling basin receives high velocity discharges. Basin in good condition.	
EMERGENCY GATE	None. Log passage could be used to help draw down the dam, but cannot be put into use quickly due to removal of hoisting equipment.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Founded on rock. No erosion, swift discharge; clear with no debris or obstructions.	
SLOPES	Good slope but not severe.	
APPROXIMATE NO. OF HOMES AND POPULATION	Small lake community downstream 1 mi. Approximately 12 homes and/or summer cottages.	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Long narrow lake. Immediate upstream area shows no significant slopes.	
SEDIMENTATION	None observed.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE 1

NAME OF DAM Indian Lake Dam
ID # 155

ITEM	REMARKS
AS-BUILT DRAWINGS	
REGIONAL VICINITY MAP	
CONSTRUCTION HISTORY	
TYPICAL SECTIONS OF DAM	
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	
RAINFALL/RESERVOIR RECORDS	

ITEM	REMARKS
DESIGN REPORTS	
GEOLOGY REPORTS	
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	
POST-CONSTRUCTION SURVEYS OF DAM	
BORROW SOURCES	

ITEM	REMARKS
MONITORING SYSTEMS	
MODIFICATIONS	
HIGH POOL RECORDS	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	
MAINTENANCE OPERATION: RECORDS	

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	

CHECK LIST
HYDROLOGIC & HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 121.7 sq. mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1650

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): --

ELEVATION MAXIMUM DESIGN POOL: --

ELEVATION TOP DAM: 1657

CREST:

a. Elevation 1650
b. Type Masonry Weir
c. Width 6 feet
d. Length 6 @ 17.5 = 105
e. Location Spillover North End
f. Number and Type of Gates ---

OUTLET WORKS:

a. Type Sluice gate closure to 5 ft. dia. steel pipes.
b. Location Center of dam.
c. Entrance Inverts 1613
d. Exit Inverts 1613
e. Emergency Draindown Facilities ----

HYDROMETEOROLOGICAL GATES:

a. Type ----
b. Location ----
c. Records ----

MAXIMUM NON-DAMAGING DISCHARGE: ----

APPENDIX B

PREVIOUS INSPECTION REPORTS

AND CORRESPONDENCE

INTERNATIONAL PAPER COMPANY
220 EAST 42ND ST., NEW YORK, N.Y. 10017, PHONE 212 490-6000

September 14, 1978

RECEIVED
SEP 18 1978
DALE ENGINEERING COMPANY
BY........................

Mr. Neal F. Dunlevy
Stetson & Dale
Bankers Trust Building
Utica, New York 13501

Dear Mr. Dunlevy:

Attached is a copy of the Kleinschmidt & Dutting study report of the Indian Lake Dam as you requested. Also, I am sending to Kleinschmidt & Dutting a copy of your letter dated September 5, 1978 for their information.

Your letter was taken up in the annual meeting of the Indian River Company on September 12, 1978. They are anxious to cooperate with you in any way they can.

Please feel free to contact Leo Bernier at the Hudson River Mill for any additional information he may be able to provide.

Very truly yours,

C. S. Nichols

C. S. Nichols

CSN:jtb

Attachment

cc: P. L. Berube
L. E. Bernier
R. E. Brubaker

INSPECTION AND STUDY REPORT
ON THE
INDIAN LAKE DAM
INDIAN LAKE, NEW YORK

BY
KLEINSCHMIDT & DUTTING
CONSULTING ENGINEERS
PITTSFIELD, MAINE

JULY 1978

HYDRAULICS WATER SUPPLY WASTE DISPOSAL

Kleinschmidt & Dutting
Consulting Civil Engineers

73 MAIN STREET
PITTSFIELD, MAINE 04967
Phone: 207-487-3328

International Paper Company
220 E. 42nd Street
New York, New York 10017

Attention: Mr. Leo Bernier

SUBJECT: Inspection and Study of Indian Lake Dam

Dear Mr. Bernier:

Attached is a report of our inspection and study of the Indian Lake Dam located in Indian Lake, New York. The study and report are in accordance with our proposal of May 5, 1977. The study proved to have several unexpected delays as well as several interesting results.

The dam is in good physical condition with no major maintenance or structural problems. Several shortcomings are sited in the body of the report.

The hydrological study of the dam and the drainage basin indicated that the dam has inadequate spillway capacity to pass the probable maximum flood as presently defined by the state of the art. This fact indicates that the design flood that was used to construct the dam is less than the flood presently used to test the adequacy of a structure.

The stability analysis of the structure indicated that the earthen portion of the dam and the non-overflow portion of the dam are stable under both normal conditions and the probable maximum flood conditions. The spillway portion of the dam is stable for floods up to a recurrence interval of years but could fail for flows approaching the probable maximum. While this fact should be of concern, the report discusses the merit of this possible failure. Such a failure would act as a safety valve to prevent other more critical portions of the dam from being overloaded or loaded to the limit. It appears that the spillway failure would be self-restraining. Failure of a part of the spillway portion would increse the discharge capability and thereby reduce the pond level.

The study has indicated that while the maximum probable flood would have a significant effect on the river flows downriver of the Indian Lake Dam, the flows will not be significantly increased as a result of the dam. This conclusion is based on the criteria and assumptions generated in the study.

The above items as well as others are covered in detail in the main text of the report.

Paul L. Berube

Richard F. Dutting, Partner
Kleinschmidt & Dutting

GENERAL

In accordance with our proposal of May 5, 1977, this is a report of the inspection and study of the masonry dam at Indian Lake, New York. The dam is about 47 feet high with an overall length of 550 feet. The dam was built around 1898. The dam presently serves as a water storage structure for downriver uses as well as for maintaining the water level for the recreational area surrounding Indian Lake.

The dam consists of three sections; an earthen section about 210 feet long on the southern end, a granite block masonry non-overflow section about 170 feet long in the center, and a granite block masonry spillway section about 170 feet long on the northern end. The earthen section varies in height from about 12 feet to about 45 feet, while the entire center section is from 45 to 47 feet high and the northern spillway section varies in height from about 12 feet to 40 feet.

Objective

The scope of the study and this report is to perform a thorough physical inspection of the dam structure above and below the water surface. The study also includes a hydrologic examination of the Indian Lake drainage area to evaluate normal and flood flow conditions. Spillway capacity of the dam structure is important and is a major consideration of the study. The stability of the dam structure is also of major importance and the stability analysis of the structure under normal and flood conditions is covered in the study. All the above points of study are of importance to the main concern of what effects the dam may have down river during flood flow conditions should the dam fail. The study is documented and presented in this report of observed and estimated conditions with any conclusions and recommendations that we determine appropriate.

Program

The program established for this project can be broken down into four main parts. The first part is labelled physical and it involved the actual inspection and evaluation of the dam structure and the surrounding terrain and conditions.

Common areas of concern and types of potential problems looked for are cracks, settlement, shifts, deterioration, loss of riprap protection, inoperable or misused discharge structures, and inadequate drainage evidenced by abutment leaks, boils or seeps.

The second part is hydrological. It is necessary to analyze the drainage area to assess the water flows that do occur as well as those that could occur during flood periods. The objective of the hydrological study is to determine the flows and the resulting water elevations at the dam site. In addition to the many varied parameters associated with precipitation and runoff, the reservoir and the dam structure are critically important in determining the hydraulic capacities of the site. This part includes complete hydraulic analysis of the dam to determine discharge capacities.

The third part of the program is the stability of the dam structures. After the dam has been inspected for physical distress and the hydrological study has provided information on predictable operating conditions, the various sections of the dam must be checked for stability. A dam under load can fail in several ways. The weight of the water may push the dam or a section of the dam down river and produce a sliding failure. The force of the water behind the dam may tip the dam over and produce an overturning failure. Uplift pressures from the bottom of the dam may combine with the forces above to cause either a sliding or overturning failure. Seepage through, under, or around the dam may lead to failure by piping, undermining, or sloughing. Overtopping earthen portions of a dam can produce a washout failure.

The Indian Lake Dam has been an existing structure for many years so the major concerns are those that would result from deterioration or long term progressive failures, or failures from flood forces that have not yet been experienced at the site. The stability analysis based on the flows of the hydrological part establish a level of confidence for the dam for as yet unexperienced flood flows. The detailed inspection of the physical part attempts to identify and locate any signs that the dam is weakening or becoming unstable through long term progressive failure or deterioration.

The fourth part of the program can be called downstream considerations. This part of the program is entirely dependent on the results of the first three parts. If the study to this point indicates that the control structures will not be overtopped and are stable then there is no reason to investigate downriver effects of the flow. Likewise, if the dam is overtopped but the overtopping does not result in a predicted failure, there is usually no reason to investigate downriver effects of the flow. However, any predictable failure makes the entire report subordinate to what effects this failure would have on life and property downriver of the failure site. The owner of a dam site does not usually have control of downriver areas or activities. This lack of downriver control means that the only way of reducing danger to public safety and property damage is to modify the structures to safely pass the indicated flows or else reduce the flows by additional upriver control structures. While life and property are always in danger during any flood condition, the responsibility of a dam owner logically is limited to the additional effects that would occur if a dam fails over that which would occur if the dam did not fail.

PHYSICAL INSPECTION

The dam was inspected on September 8, 1977 by Mr. Paul L. Berube of Kleinschmidt & Dutting with the help of Mr. Charles Finkelstein and Mr. William Saidel both of Sub-sea Surveyors Incorporated. Mr. Harr, caretaker of the dam for International Paper Company, provided administrative assistance and general site information.

The water level was about one foot below the spillway crest during the inspection. Water was being discharged through the flume gates to maintain minimum downriver flows. Visual inspection of the portions of the dam showed a number of conditions. The earthen section of the dam was true to shape with no signs of settlement or sloughing. The upriver face was very well riprapped with no apparent defects. The downriver face and the top of the earthen dike was heavily covered with small trees and brush. Such growth should be removed and kept from re-establishing itself in the future. The trees present a potential for future concerns because of the root systems that develop in the dikes. Larger trees may blow over and damage the surface of the dike and result in future erosion. If overtopping does occur, trees uprooted could speed the washout failure of the dike. Some seepage was noticeable on the downriver toe of the dike, but the amount was not sufficient to cause any erosion or sloughing.

A granite block wingwall separates the downriver earthen section from the non-overflow section. This wall has evidence of long periods of slow seepage across the majority of its face. The only active weeping at the time of the inspection was along the toe of the wingwall and a flow of about one half gallon per minute coming from a joint between two granite blocks several feet from the bottom of the wall. No evidence of any harmful effects of this seepage could be found. Routine observation of the situation is the only action that is in order. All such observations should be recorded to enable a quantitative evaluation from time to time to insure that any worsening of the condition will be detectable and permit timely scheduling of remedial action.

The stone block portions of the dam were carefully inspected both above and below the water surface. The masonry sections appear to be structurally sound with no signs of shifting or any type of movement. All the lines of the structure appear straight and true to the original shape. No masonry parts were noticed out of plumb or misaligned. The downriver face of the masonry indicates that minor amounts of weeping have occurred over the majority of the surface below the water line for long periods of time. Ten to twenty percent of the downriver surface below the pond water line was wet from seepage at the time of the inspection. This seeping does not pose any special structural or safety problems at the present but again the conditions should be documented periodically to allow quantitative evaluations of any worsening of conditions in the future. Mr. Harr noted that he could remember twenty years ago when the masonry used to leak a considerable amount and water squirted from the joints on the downriver face. Since that time, the entire masonry portion of the dam has been sealed with a cementous material.

A substantial growth of trees about ten feet tall has established itself along the downriver toe of the non-overflow section. Small trees have even established themselves in the joints of the block masonry face. All such growth should be removed and not allowed to re-establish itself.

As noted earlier, the masonry portion of the structure has had a grout sealer applied to it sometime in the past. A few areas of this grout has spaulled off and other areas appear to have weathered off.

In general the block joints above the water line appear to be in good shape with only an occasional joint in need of repointing.

The gatehouse is located in the center of the dam and houses two electrically operated flume gates. The gatehouse is constructed of block masonry that is in excellent condition.

The flume gates were operated to test their ability to function. The gates were closed to stop the water flow and allow divers to investigate the masonry dam below the water line. The gates opened properly but would not close tightly and stop the flow completely. This fact is a maintenance item and probable of little concern since the leakage was minor and a minimum downriver flow must be maintained anyway.

Very minor quantities of frost spaulling was noted on the masonry sections of the dam. This spaulling involved only the cementous coating and is not significant.

Five cracks were noted on the concrete cap that extends across the non-overflow section of the dam. Only two of the cracks extend into the block masonry of the dam. Very close inspection of these fine cracks (less than 1/8 inch in width) revealed that absolutely no movement has taken place at the cracks other than the formation of the cracks themselves. The cracks appear to be quite old. No problems related to these cracks could be found. These two cracks are located 84 feet and 129 feet from the south end of the non-overflow section.

A copy of the diver's reports of the under water inspection is appended to this report. In general, the divers reported that the masonry below the water line was in good condition. Some random joints and small holes have spaulled open but the extent of this deterioration does not merit special attention at this time. Holes and joints should be repaired if the structure is dewatered, but dewatering should not be done just to patch the masonry face. The condition will obviously worsen as time goes on and maintenance will be needed sometime in the future. Periodic review of the underwater face will allow timely maintenance when the condition worsens and repairs are required.

The divers also indicated that the trash racks and gates were in desperate need of cleaning and probable repair. Clogged racks and gates restrict the discharge capability of the dam in case of flood flow conditions.

The log sluice is no longer used and the sluice opening has been gated with a steel gate. However, there is no equipment to open the gate. The lifting beam is about five feet above the top of the gate so that a chain fall could only lift the gate a few feet. This situation restricts the actual flow capacity of the dam since the gate would probably remain closed or only opened a few feet during an actual flood condition.

Conclusions:

The physical inspection of the dam indicated that the entire structure appeared in good structural condition and appeared free from any signs of potential or developing safety hazards. Several maintenance items should be undertaken in the near future. They include removing the trees and brush from the earthen section of the dam from the downriver toe of the dam and from the joints of the block work. The racks and gates should be cleared of any debris that has built up.

Several items should be inspected and the results documented for future reference. These items include seepage at the toe of the earthen section, seepage through the wingwall, seepage through the block masonry section,and holes and joints spaulling below the water line.

Two operational items should also be considered. First the log sluice could be modified for active use during high flow conditions. Second, no auxillary method of operating the flume gates was noticed. A power failure during flood conditions could find the gates in a closed position with no way of opening them.

HYDROLOGICAL

The hydrology of a drainage area is unique to that drainage area and is dependent on a very large number of factors. Most of these factors are not only variable between drainage areas but are also variable within a single drainage area. In addition, the many factors are interrelated with each other and form a seemingly hopeless tangle of possibilities that could result from the hydrology of a single drainage basin. The hydrologic conditions that this report is concerned with are the extremes that could be expected as a "maximum probable precipitation" that could result in a "maximum probable flood" flow. The entire subject from meteorolgy to river flows can be very complex and the science or art of predicting natural occurances is far from exact.

While methods are available for predicting the "possible maximum precipitation" and the "possible maximum floods" it is not reasonable to design or consider the largest precipitation that could theoretically occur. The "possible maximum" concept requires that every possible natural occurance and variable must occur at a critical time and place. Such a combination of occurances is theoretically possible but highly improbable. A far more useful approach is the "probable maximum precipitation" and the "probable maximum flood" that can reasonably be expected to occur. The "probable maximum" concept allows for weighted judgment of the practicality of assuming critical conditions of all parameters simultaneously.

The probable maximum approach is generally accepted or required by most agencies such as the Federal Energy Regulatory Commission and the U.S. Army Corps of Engineers. The Army Corps has developed a number of computer programs to facilitate the various types of hydrology studies commonly done by the Corps. One such program is entitled HEC-1 Flood Hydrograph Package. This HEC-1 program was used to model the Indian Lake drainage area and generate the probable maximum flood. The U.S. Weather Bureau and the U.S. Army Corps of Engineers Hydrometeorological Report #33 was used to establish the appropriate precipitation values for the Indian Lake, New York area to be studied in the computer model.

A brief description of the general procedures used follows. Available weather data records are reviewed and an appropriate storm is selected. In this case insufficient data were available for the Indian Lake drainage basin, so that records of similar drainage basins were used and adjustments made to compensate for any known differences between the drainage basins. The next step is to use the computer to"reconstitute" the runoff hydrograph. This is done by selecting parameters that the computer program uses to generate a hydrography that is as nearly identical to the runoff hydrograph as possible. Once the storm has been satisfactorily reconstituted by successfully modelling certain hydrological variabilities of the drainage basin a probable maximum precipitation is selected from the Hydrometeorological Report #33. This precipitation value is fed into the computer and the program generates and routes the probable maximum flood through the reservoir. The computer program is extremely versatile and for this study the drainage basin model included the modelling of the Indian Lake Dam at Indian Lake itself.

The results of the computer study indicated that a probable maximum precipitation of 19 inches would produce a maximum inflow to Indian Lake of approximately 26,000 cubic feet per second and a maximum outflow at the dam site of approximately 16,000 cubic feet per second. The elevation of the lake would go from its normal full elevation of 1650 feet to an elevation of 1659 feet.

Two nearby drainage basins were used to model the Indian Lake basin. These basins were the Newcombe River with a drainage area of 192 square miles and the East Branch of the Sacandaga River with a drainage area of 114 square miles. Indian Lake's drainage area is approximately 132 square miles.

Several assumptions were made about the operation of the dam. The Lake was assumed full at elevation 1650 feet at the start of the storm. The flume gates and the log sluice were assumed opened once 0.2 feet of flow was going over the spillway. The drainage basin was modeled as a single drainage area with no sub areas.

Actual operating and starting conditions may vary from those assumed above, but a set of starting values is necessary and the values used are assumed reasonable unless more detailed information becomes available. Differing actual conditions would make the results more conservative or less conservative than the values generated in the study. The question of probability versus possibility comes into play again.

The flows indicated above are large and must be placed in the proper perspective. A standard calculation of the recurrance interval of a storm that would produce a runoff of 16,000 cfs from the Indian Lake drainage basin resulted in a recurrance interval in excess of one million years. This means that a flood of that magnitude will not occur on the average of once in one million years or more.

Conclusions:

The hydrological portion of the study indicates that the probable maximum precipitation would produce a substantial runoff flow from the Indian Lake drainage basin. Routing the runoff flow through the lake reduces the flow from about 26,000 cfs into the lake to about 16,000 cfs out of the lake. This dampering effect caused by the storage in the lake as the water rises is very beneficial to everything downriver of the dam. The study indicated that the lake surface elevation would increase to 1659 feet. This elevation is 2 feet above the walk on the spillway and the non-overflow sections. This elevation is the same elevation listed for the earthen section of the dam. Calculations or assumptions were not manipulated to keep the flows and elevations at or below the capacity of the site. It is merely a matter of happening that the probable maximum flood flows and the resulting water elevations just matches the capacity of the site without over topping the earthen section and causing a washout failure. Over topping of the non-overflow section indicates that the probable maximum flood exceeds the capacity of the design flood of the dam.

STABILITY ANALYSIS

The stability of the dam means static stability for purposes of this study. Water pressure and the weight of the dam are the major forces concerned. Since ice pressures are considered to occur at normal pond levels but not at flood flow levels, ice pressures are not included in any stability analysis. The structure has gone through 80 winters of ice at normal pond levels with no signs of adverse effects. No further verifications were considered necessary for ice pressures.

The forces acting on the dam can be separated into two groups. The first group is the stabilizing forces which act to hold the dam in place and prevent the structure from failing. These forces consist of the weight of the dam itself, weight of any water resting on the dam which adds to the weight of the dam, and the strength of any anchoring or bracing devices which may be included in the dam.

The second group of forces is the unstabilizing forces which act to move the dam by overturning it or sliding it down river. These forces consist of the pressure of the water against the face of the dam and the uplift pressure under the dam. Uplift pressures are the result of water seeping or flowing through the dam or its foundation. Uplift pressures can vary greatly and they are difficult to estimate without actual measurements. These uplift pressures cause a reduction in the effective weight of the dam and thereby reduce both the dams sliding and overturning resistance. Most dams have some uplift pressures and the mere presence of such pressures is not a sign of a failure or pending failure.

Stability of the masonry dam was checked at two sections. The two sections were the typical sections of the non-overflow portion and the spillway portion as shown on International Paper Company Drawing 3.P.V. 246S-A. These sections were checked for stability under both normal and probable maximum flood levels. Stability was checked for a condition of no uplift pressure and a condition of uplift pressure that varied from 50% of the pond height at the upriver heel of the dam to no uplift pressure at the downriver toe of the dam. Without detailed field measurements there is no way of predicting which of the uplift conditions is closest to the actual condition.

It is accepted criterion that a dam section is conservatively stable against overturning and requires no special study if the resultant of all the forces acting on the section falls within the middle third of the base area of the dam provided no unusual conditions are present. The stability calculations show that both sections are stable under normal water elevations for the conditions assumed from previous parts of this study. The resultant of all the forces falls within or very near the middle third of the base area. Both sections are also safe against sliding failure under normal water conditions. The above findings are consistent with the fact that the structure has remained in place for eighty years.

The stability calculations of the section during the probable maximum flood elevation of 1659 feet showed different results. The resultant of the non-overflow section fell near the one quarter point of the base rather than between the one third and two thirds points. While this resultant position is outside the conservative safe zone, other considerations indicate that the section is stable under the assumed conditions. The safety margin against sliding is also greatly reduced during the flood elevation but it is still within acceptable limits.

The resultant of the spillway section during flood elevations falls near the one eighth point and while the actual physical conditions may prove the section to be stable there is a reasonable probability that parts of the spillway section would be overturned. In addition sliding resistance of the section has been exceeded and the section may move downriver under the conditions studied. A combination of the overturning and the sliding potential makes it reasonable to say that the section may be found in place after the maximum probable flood recedes but the probability is that the spillway section will be breached to some extent.

The probability of failure of the spillway section under the probable maximum flood flows does have considerable merit and should not be considered a completely undesirable event. Without the spillway failure the water level is predicted to rise to the top of the earthen section and the non-overflow section is predicted to be nearing its limits of safety. Failure of a part of the relatively shallow spillway section will increase the discharge flow but more importantly it will prevent the water level from topping the earthen section or endangering the non-overflow section. Either of these alternate failures would be more severe. Failure of the non-overflow section would be especially critical since it would probably result in complete failure of the entire 170 foot long by 47 foot high section. The spillway section would act as a safety valve to prevent a more extensive failure of the other portions of the dam.

If we assumed that 50% of the spillway portion of the dam is lost, an additional discharge capacity of 6000 cfs would be created at a water elevation of 1659 feet. However, since the spillway section will probably fail before the water reaches elevation 1659 feet, somewhat less than 6000 cfs additional discharge would result. Additionally, the estimated discharge would be somewhat less than the calculated 16,000 cfs because of the reduced water level. It appears likely that the combined total discharge with a 50% spillway failure would be approximately the same as the discharge that would occur if the spillway remains in place. The greatest effect that such a failure would have would be to produce an increased flow until the water level subsides to the bottom of the breached portion rather than the normal dam crest.

It should be noted that all the conditions discussed above produce a discharge that is substantially less than the natural flow of the site represented by the lake inflow figure of 26,000 cfs.

Table 1 shows the results of the stability analysis of the two sections studied.

Because of the nature of the spillway construction and an absence of detailed field measurements, it is impossible to know at exactly what water level and flow conditions the spillway would start to fail. Failure of a granite block structure such as the spillway often occurs by the blocks "unravelling" from the top a few blocks at a time. While insufficient data is available to absolutely assure a point of non-failure, we feel confident that the spillway will remain undamaged with a pond elevation of 1655.5 (5.5 feet above the spillway crest). This elevation is just under the walkway support members. The approximate discharge capability of the spillway (log sluice and flume gates assumed closed) under these water conditions is 4500 cfs. This flow corresponds to a recurrance interval of 10,000 years. In other words, the spillway should be free of damage from a flood with a magnitude that will not occur on the average of more than once in 10,000 years or more.

TABLE 1

RESULTS OF STABILITY ANALYSES

Section	Location of Resultant *	Sliding Factor **
Non-overflow		
Case 1-A	-	-
Case 1-B	0.46	0.52
Case 2-A	0.36	0.65
Case 2-B	0.27	0.83
Spillway		
Case 1-A	-	-
Case 1-B	0.31	0.16
Case 2-A	0.33	0.69
Case 2-B	0.14	1.08

Case 1 : Normal water elevation of 1650 feet.

Case 2 : Flood water elevation of 1659 feet.

Case A : No uplift forces acting on the dam.

Case B : 50% of static pressure acting as uplift pressure at the upriver heel and reducing to no uplift pressure at the downriver toe.

* Location of the resultant is given as a decimal fraction of the base width of the section. Values from 0.33 to 0.67 are conservative.

** Sliding factor is the sum of the horizontal forces divided by the sum of the vertical forces.

Conclusions

The stability analysis indicates that the earthen portion and the non-overflow portions of the dam appear safe but are approaching the limits of safety. The spillway section appears to be unstable at the probable maximum flood conditions. The probable failure of a part of the spillway section will act as a safety valve to protect the non-overflow and the earthen portions of the dam. The flow increase caused by 50% spillway failure should not exceed the maximum outflow that would result without the failure.

It must be emphasized that the entire procedure from precipitation prediction to the question of if and when a failure would occur is based on probabilities and reasonable assumptions. Variations of one or more factors will obviously make the results either more conservative or less conservative. Additional discharge or by-pass capability to reduce the water level during flood conditions would make the site more acceptable from a conservative view point. However, a more detailed study may reveal that additional discharge capability may not reduce the total discharge from the site from the present situation. The only advantage may be to completely control the discharge and control the lake at crest level rather than an unknown breached level.

DOWNRIVER CONSIDERATIONS

Much of the concern about the dam safety has little to do with the dam itself. Major concern often centers around the effects that flood flows have on persons and properties downriver of the dam site. The first parts of this report have dealt with the physical condition of the dam, the hydraulic capacity of the dam, the flows that the dam will probably be subject to and the static stability of the dam under these hydraulic loadings.

The findings indicate that the maximum probable flood will defintely press the structure to its limits and will probably cause a partial failure of the spillway area. However, the dam will probably stand the flood without the complete and catastrophic failure of the larger center or earthen parts of the dam. The failure that seems probable would not significantly increase the downriver flow beyond the flow that would result if the structure remained completely in tact.

The flood flows discussed in this report will certainly have an effect on downriver areas. Since it appears that the dam structure would continue to damper the peak discharge of the drainage basin of the dam from 26,000 cfs to 16,000 cfs, our conclusion based on the criteria and assumptions of this study is that the Indian Lake Dam would not pose an increased danger to downriver population and property during a probable maximum flood.

While it is obvious that the road causeway and small bridge downriver of the dam would be flooded along with some camps and maybe even the highway bridge on Route 28, no detailed investigations were made of downriver conditions based on the conclusions of the above paragraph.

APPENDIX

SubSeaSurveyors inc

DIVERS / SALVORS / OCEAN ENGINEERS

P.O. Box 20157
San Diego, Calif. 92120
(714) 287-2526

P.O. Box 295
Eliot, Maine 03903
(207) 439-3330

10 October, 1977.

DAM INSPECTION AT INDIAN LAKE DAM,

INDIAN LAKE N.Y. SEPTEMBER 8, 1977.

F O R

KLEINSCHMIDT & DUTTING,

73 MAIN STREET,

PITTSFIELD, MAINE, 04967

Sub Sea Surveyors inc.
DIVERS / SALVORS / OCEAN ENGINEERS

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ABSTRACT

Sub Sea Surveyors was contracted by Kleinschmidt & Dutting to conduct a one day visual underwater inspection of the Indian Lake Dam at Indian Lake, N.Y. The prime purpose of this survey was to determine this overall structural integrity of the dam through visual only means. Mr. Berube, Consulting Engineer from Kleinschmidt & Dutting was on site during the inspection.

No major structural damage was sighted, however the cement like facing material was chipping away from the dam face in several locations exposing the primary dam rock wall. Three of the four upstream gates were heavily fouled with logs and miscellaneous debris.

PROCEDURE

The dam was marked off in 5 feet increments (stations 1 through 40)(see dam map provided by KleinSchidt & Dutting). One diver would make vertical descents along each station. A safety line was attached to the diver. This line was also marked off in 5 foot increments. When photographs were taken, the tender was signaled and the divers depth and position was recorded.

It is Sub Sea Surveyors policy when conducting dam inspections to have precise diver navigation so that we are sure 100% that the dam has been inspected and that any faults found in the dam can be relocated. It was explained to us that this kind of accurate inspection was not necessary in this case, but rather an overall safety inspection of the dam was all that was required. At Mr. Berube's request we did relax our navigation requirements so that we could cover the entire dam area in a shorter period of time.

RESULTS

The outer facing of the dam was covered with a layer of a cement like material. We were informed by Mr. Berube that a major maintenance was conducted some 15 years ago. This thin layer of cement is now chipping away from the dam leaving exposed holes between the large rocks. Some of these holes have been filled in with smaller stones. In some areas these smaller stones have loosened and are easily removed by hand if they have not yet fallen out.

./.

SubSeaSurveyors inc.
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RESULTS (Cont'd)

The enclosed photographs show a representation of holes and of the outer layer chipping away.

There was no evidence of cracks or stone shifts in the dam face. There were no leaks detected in the dam face. However, photograph 1-35 shows a possible crack in a stone block. This possible crack corresponds to a crack along the top of the dam but there was no evidence of shifting. This crack was called to the attention of Mr.Berube.

Because of the heavy staining of the lake water, the photographs taken of the valve gates were under exposed even with the use of the high powered strobe and the fast film.

Three of the four upstream gates (North side, North front, South side) were abstructed by lake debris (see figure 1). Debris consisted mostly of broken tree limbs, logs, leaves, etc. The limbs and logs intertwined to form a net-like structure in such a fashion that the three blocked gates were not visible. (See figure 2)

The South front gate was free of debris either protruding into or in front of the gate. No internal abstructions were visible. The grating infront of the gate valve was in place, however, it was badly rusted and some of the bars were broken free.

Figure 3 shows bottom depths around the gate house structure. It also shows the steep ledge near the north gates. The ledge could act to funnel the flow of water and debris to the north gates. It is also possible that the south front gate is not operational, thus no flow and no debris. The south side gate is located at a dead flow zone. This would act to concentrate debris on the south side.

Adjacent to the south front gate is a pipe opening approximately 5 inches in diameter. It is located between the south front gate and the south front corner approximately 2 inches from the bottom. It is free of any abstructions (see figure 1).

Figure 4 illustrates a profile of the steel door. The wood debris located at the obstructed gates was not evident at the base of the steel door. Salt and dirt filled in the lip as illustrated in figure 4.

Sub Sea Surveyors inc

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CONCLUSION

There was no major damage found. No serious shifting of stone was observed. It was found however that a complete maintenance to the 4 valve gates should be done as soon as possible.

If a visual record of the valve gates is required, Sub Sea Surveyors recommends that a complete maintenance inspection be conducted with an underwater television. This will present a clear record of the valve gates and all cracks and holes in the dam face. Sub Sea Surveyors has the capability to conduct a complete dam maintenance survey as well as the gate clearing and maintenance requirements with the same experienced diving crew.

PRELIMINARY WORKING SKETCH

Fig. 1: Gate Location upstream

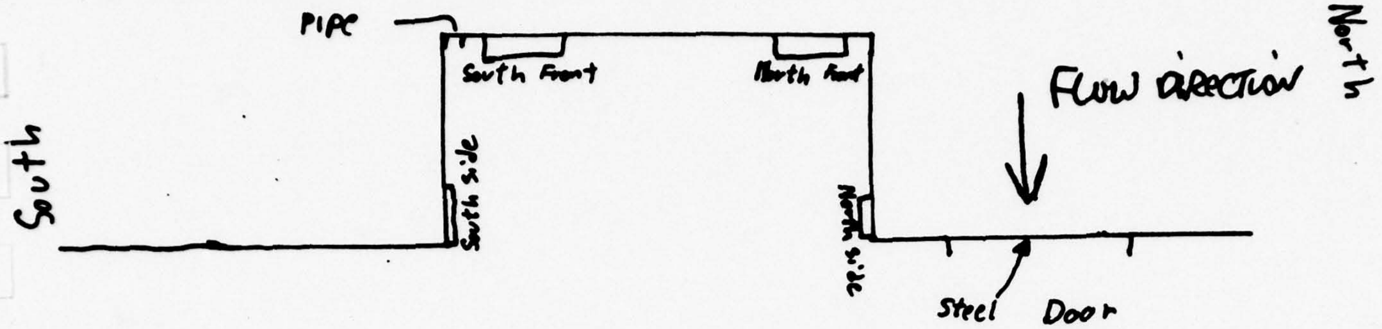
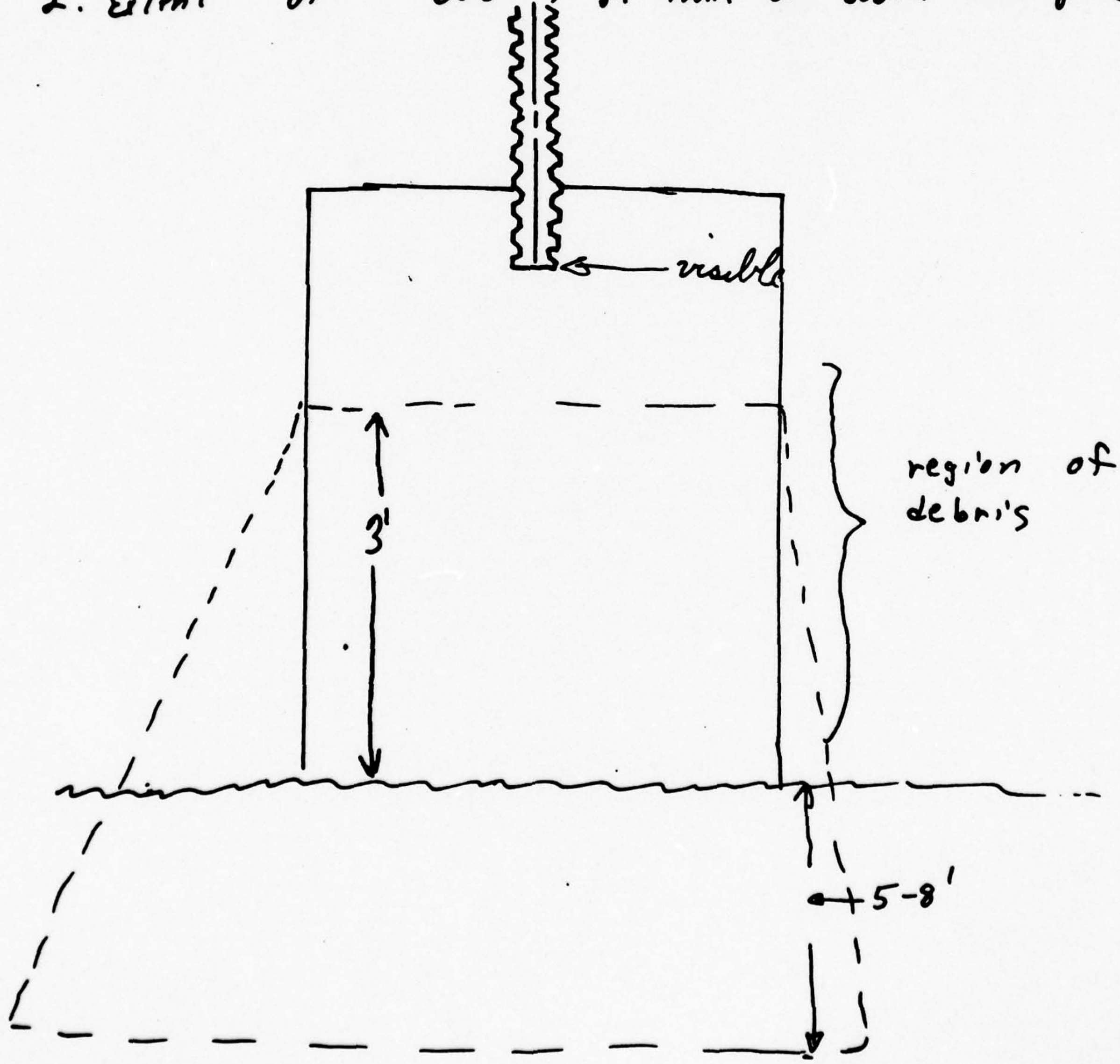


Fig 2: Extent of Debris in front of South Side gate



DEBRIS: BROKEN TREE LIMBS, PULP WOOD, MISC HEAVY TRASH – GATE SEATS OR TRACKS

Fig. 3 : Depth Contour Depths at Bottom

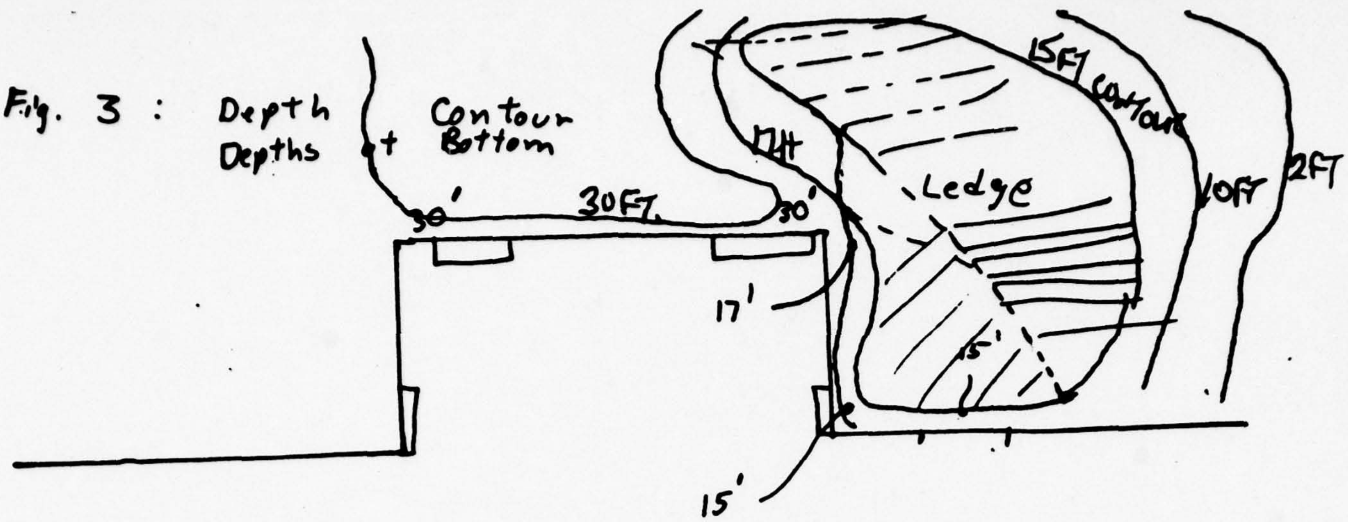
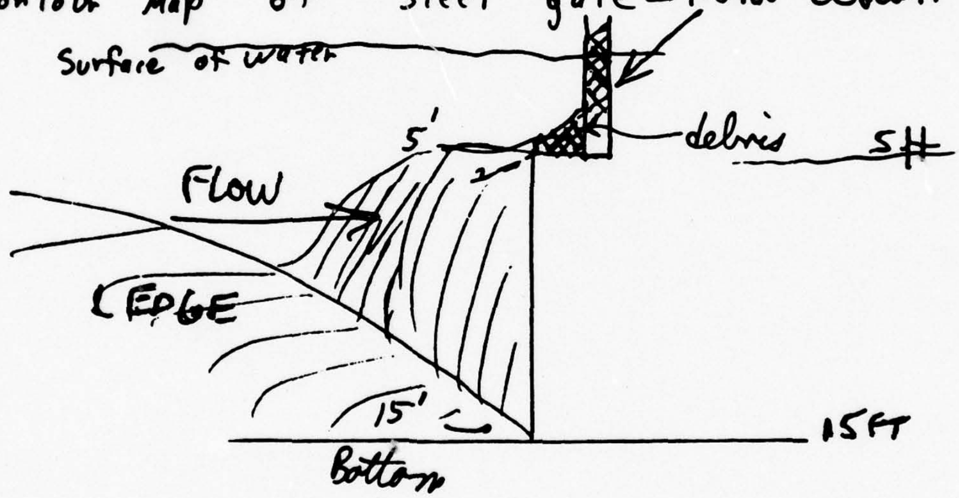


Fig. 4: Contour Map of Steel gate—MAN LOGWAY



PRELIMINARY SKETCH

April 29, 1919.

MEMORANDUM REGARDING INDIAN LAKE DAM

Indian Lake Dam is a composite structure consisting of a masonry portion with a maximum height of forty-seven feet, seven feet wide on top, an earth section on the east end and a spillway section on the west end. This structure was erected in 1898. It appears to be a well executed piece of masonry and earth work, and is reported to have cost the contractor about $83,555, although the contract price may have been considerably more.

Owing to the loss of the minutes of the Forest Preserve Board, under whose administration the land on which the Indian Lake reservoir is situated was purchased, there is considerable uncertainty as to the exact methods pursued in the financing of this enterprise. It would appear from such fragments of information as exist, that the State purchased the land for $164,000, with the understanding that the dam which was then contracted for but not built should be completed by the Indian River Company which sold the land to the State, and that in order to insure such completion a part of the purchase price was withheld and paid from time to time to the contractor. The deed of the lands to the State, however, reads in part as follows:

"Also excepting and reserving to the party of the first part, its successors or assigns the right perpetually to maintain, use, control and operate the dam now, as well as such as may hereafter be raised, constructed, repaired or improved, at the outlet of Indian Lake, and also such other dam or dams as may be constructed, across the Indian River, lower down said river (whether located on the above described land or not); also to flow all the land which the waters raised by such dams will cover; also to flood the lands by drawing the waters from the ponds raised by said dams as per the usual course of river driving for lumbering purposes; also the right, at any and all times, of entering and operating upon said lands, so far as may be reasonably necessary to construct, repair and maintain said dams, float and driving out logs, and operate and control said dams, and to appropriate and use so much of the rock, stone and soil of said lands as may be reasonably necessary to appropriate or use for constructing and maintaining said dams. The foregoing reservation to be subject, however, at all times to the right of the party of the second part by the Superintendent of Public Works to draw water from the reservoir created by the dam at the outlet of Indian Lake, whenever, in his judgment, it shall be required for canal or other State purposes.

Also subject to the right of the purchaser of timber and logs from State lands to sluice such timber and logs over said dam in common with others upon paying his proportionate share of the expense thereof. Such sluicing to be done at the same time and with the other owners of logs, thereby economizing the use of water.

The aforesaid rights shall be forfeited and cease anything hereinbefore contained to the contrary notwithstanding, provided the party of the first part, its successors or assigns shall neglect or fail to maintain such said dam at the outlet of said Indian Lake. A breaking of said dam or destruction thereof shall not be deemed a failure to maintain the same, provided it shall be properly repaired or reconstructed within a reasonable time after such injury shall occur."

From this it would appear that it is the duty of the Indian [illegible] Company to maintain this dam perpetually and their privilege to use it for driving logs and "operate and control said dams" although the purpose of the operation other than for the driving of logs is not discussed in the deed.

It is difficult to make an estimate of the cost of maintaining this structure. Structures of this nature are among the most permanent which engineers make, if they are properly constructed in the first place. The fact that this dam has stood since 1898 and appears to be in good condition throughout, would indicate that it is a good and sufficient structure. I think that 2% upon the value of the structure would be a fair estimate of the average cost of maintenance. It should be noted, however, that this amount would be applicable from the first construction of the dam and maintenance subsequent to the present time might exceed this amount. The item of an attendant at the dam would probably amount to about $500. per year, making the total yearly expenditure somewhere about $2200.

Note: Statement of cost is given in report of the Fisheries, Game and Forest Commission for 1897 -P.407.

Division Engineer.

DWIGHT B. LA DU.
STATE ENGINEER

ARNOLD G. CHAPMAN
DEPUTY

STATE OF NEW YORK
STATE ENGINEER AND SURVEYOR
ALBANY

ADDRESS ALL COMMUNICATIONS TO
DWIGHT B. LA DU, STATE ENGINEER

December 1, 1924.

Dam No. 758, Upper Hudson
Indian Lake.

The Indian River Company,
c/o International Paper Company,
100 East 42nd Street,
New York City.

Attention of C. S. Colson.

Gentlemen:

Concerning the dam at the outlet of Indian Lake, which is designated by us as No. 758, Upper Hudson watershed, and which is we believe 2 miles distant in a direct line about south from the three way corner in the center of the village of Indian Lake:

There is a masonry pier 4' square located about 30' above the dam and about opposite the log sluiceway. This masonry pier extends to about gage height 35 and is used as an anchorage for a log boom for directing logs to the sluiceway. This pier has broken apart horizontally at an elevation 17' below its top and is tilted toward the boom until the break has opened about 2" on the upstream side. Repairs should be made by encasing the lower part of this pier in concrete. We recommend that this be accomplished during a low stage of water. We also recommend that the upstream face of the dam be repointed during a low water stage. There is particularly a place about 10' below the present water surface where the mortar has broken away from some of the joints of the stonework and which our Division Engineer, Mr. E. D. Hendricks, showed the gage reader.

The gage house roof is in a bad state of repair and should be reshingled.

Sunken stumps and other debris should be cleared away from the gate openings.

We also recommend that a standard pipe railing be placed along the top of the dam proper as it is necessary for the gage reader to cross this section during high wind storms and when the top is coated with ice this is a dangerous operation. About 150 lin. ft. of pipe railing would probably be required.

Please acknowledge the receipt of this letter and advise us concerning the above.

Very truly yours,

Dwight B. LaDu,
State Engineer

By________________________
Deputy State Engineer.

Copy to

Division Engineer Hendricks.

ARM/F.

E. D. HENDRICKS
DIVISION ENGINEER

STATE OF NEW YORK
DEPARTMENT OF STATE ENGINEER
EASTERN DIVISION
ALBANY

DWIGHT B. LA DU
STATE ENGINEER
ARNOLD G. CHAPMAN
DEPUTY

EDH-H

SUBJECT: Indian Lake Reservoir

November 25, 1924

Hon. Dwight B. LaDu,
State Engineer,
Albany, N. Y.

Dear Sir:-

I have had an inspection made of the Indian Lake Dam at the outlet of the Indian Lake Reservoir. At the time the inspection was made the water surface in the lake was 24.8 feet below the top of the dam and 17.6 feet below the crest of the spillway, the gage at the dam being 15.8.

There is one place on the dam where seepage shows. This point is located about 10 feet below the present water surface. Between the top of the dam and the water surface cement mortar has broken away from some of the joints of the stone work which undoubtedly allows some water to seep through. This is probably true below the present water surface.

The gage reader states that the dam has always leaked and does not seem to be any worse now than for a considerable time previous. The downstream face of the dam is covered with a crust of material deposited by water seeping through the masonry. A patch of this crust about 6 inches square has broken away, making visible the seepage of the water. This is the spot that is reported as a leak.

While there does not seem to be any cause for alarm I would recommend that when extremely low water occurs in the reservoir, the masonry joints of the upstream face of the dam be pointed up.

In addition to the seepage through the dam, it was observed that there is a masonry pier 4 feet square located about 30 feet above the dam, about opposite the log sluiceway. This masonry pier extends to about gage height 35 and is used as an anchorage for a log boom to direct logs to the sluiceway. This pier has broken apart horizontally at an elevation 17 feet below its top and is tilted toward the dam until the break is open about 2 inches on the upstream side. Repairs should be made by encasing the lower part of this pier in concrete. This also could be accomplished during a low stage of water.

The gate house roof is in a bad state of repair and should be re-shingled.

Sunken stumps and other debris should be cleared away from the gate openings.

I would also recommend that a standard pipe railing be placed along the top of the dam proper as it is necessary for the gage reader to cross this section during high wind storms and when the top of the dam is ice coated and is a dangerous operation. 150 lin. ft. of pipe railing would be required.

Very truly yours,

E B Vandrusen

Division Engineer

Form W51. 5-12-16-2000 (16-1673S) Acc. 382

(NOTICE: After filling out one of these forms as completely as possible for each dam in your district, return it at once to the Conservation Commission, Albany.)

Photos to follow.

STATE OF NEW YORK

CONSERVATION COMMISSION

ALBANY

S-169-P

758 UH

DAM REPORT

June 28, 1920
(Date)

CONSERVATION COMMISSION,

DIVISION OF WATERS.

GENTLEMEN:

I have the honor to make the following report in relation to the structure known as the Indian Lake Stone Dam Dam.

This dam is situated upon the Outlet of Indian Lake (Give name of stream) in the Town of Indian Lake, Hamilton County, about 2 miles (State distance) from the Village ~~or City~~ of Indian Lake

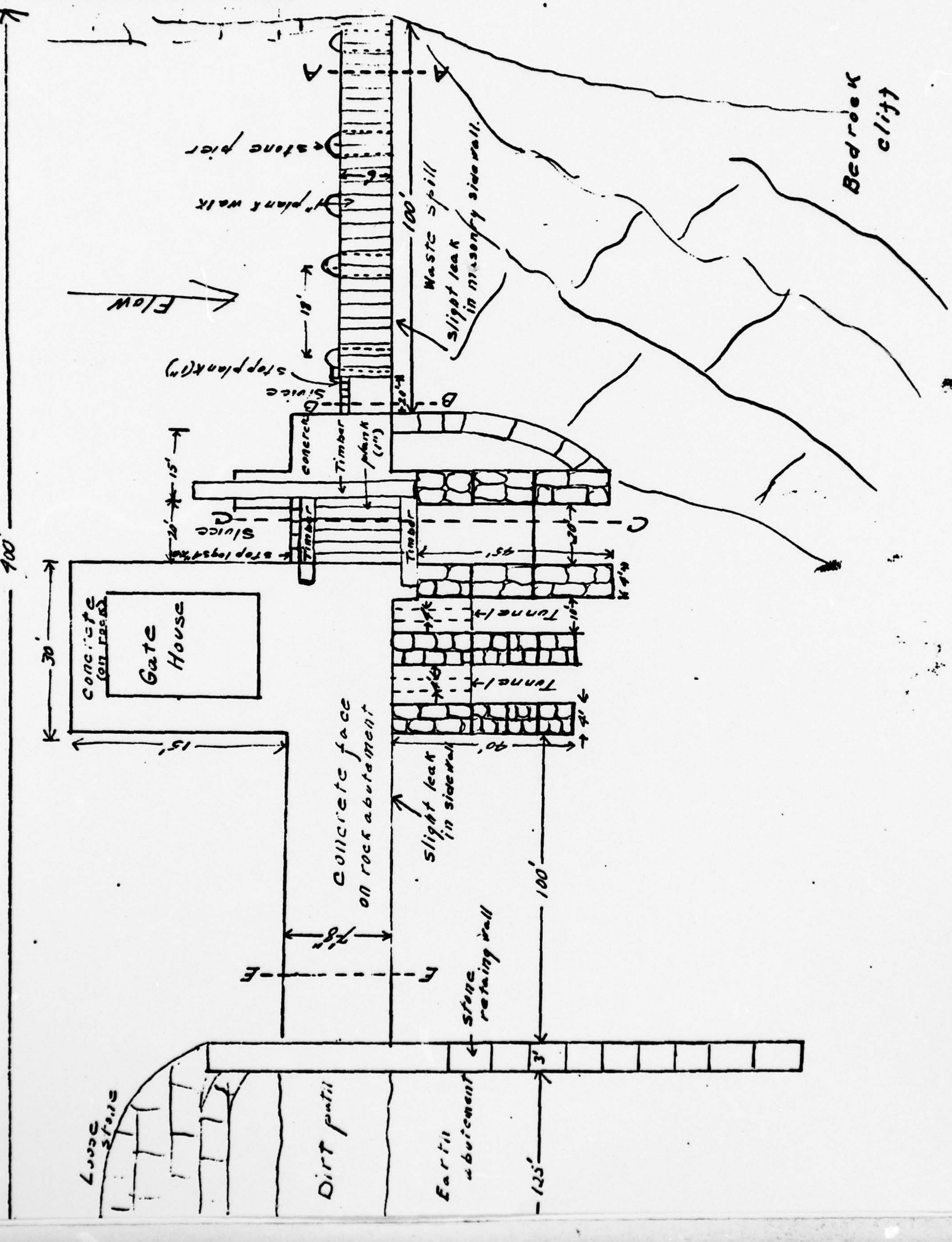
The distance down (Up or down) stream from the dam, to the Indian River Bridge (Give name of nearest important stream or of a bridge), is about 1 mile (State distance).

The dam is now owned by Indian River Co. 30 Broad St. N.Y. (Give name and address in full) and was built in or about the year 1898, and was extensively repaired or reconstructed during the year ——— and is used for: Regulating flow of Indian River for power in mills; also to maintain water level in Champlain canal.

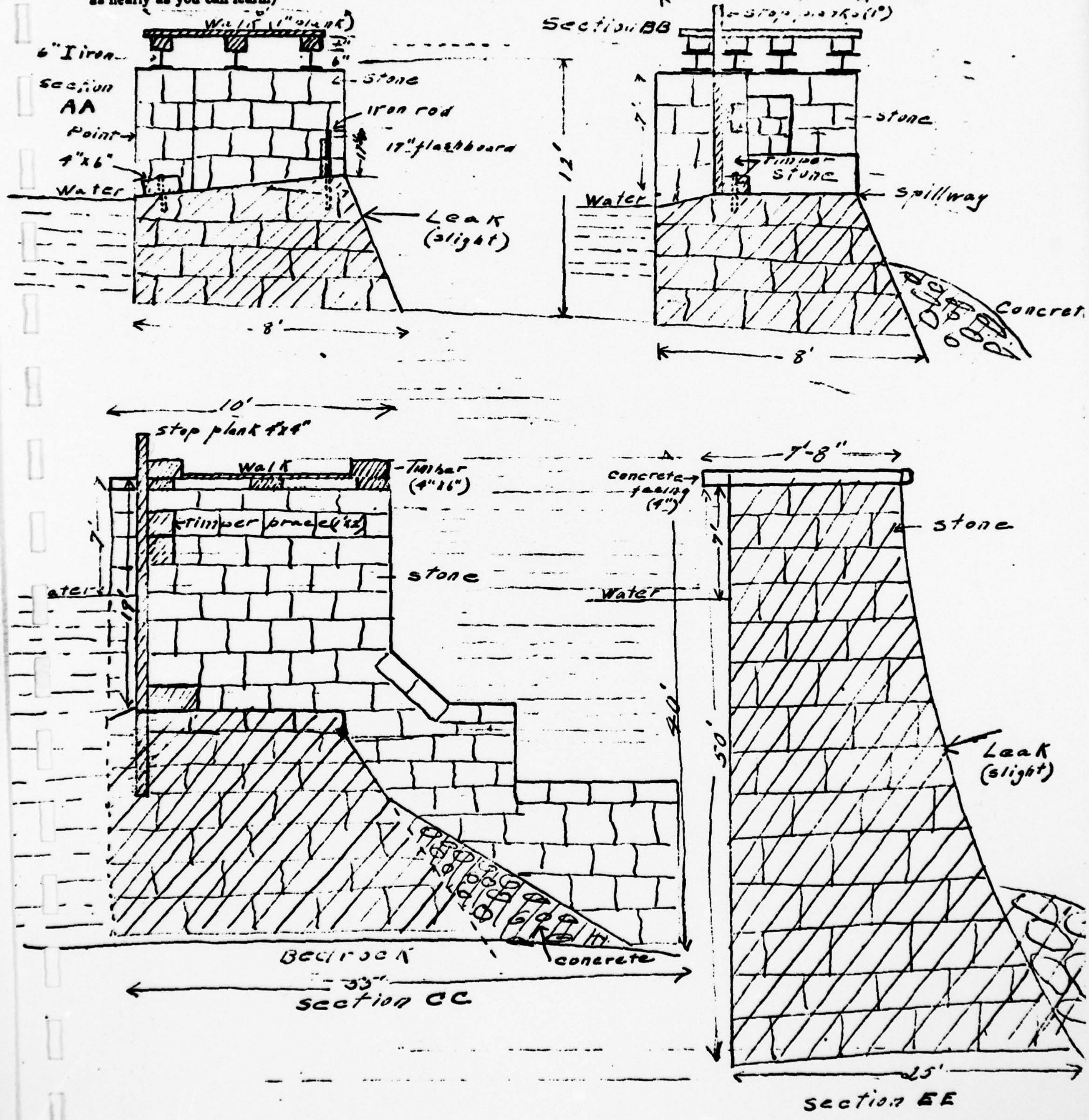
As it now stands, the spillway portion of this dam is built of masonry (State whether of masonry, concrete or timber) and the other portions are built of masonry (State whether of masonry, concrete, earth or timber with or without rock fill)

As nearly as I can learn, the character of the foundation bed under the spillway portion of the dam is bedrock and under the remaining portions such foundation bed is rock

(In the space below, make a third sketch showing the general plan of the dam, and its approximate position in relation to buildings or other conspicuous objects in the vicinity.)

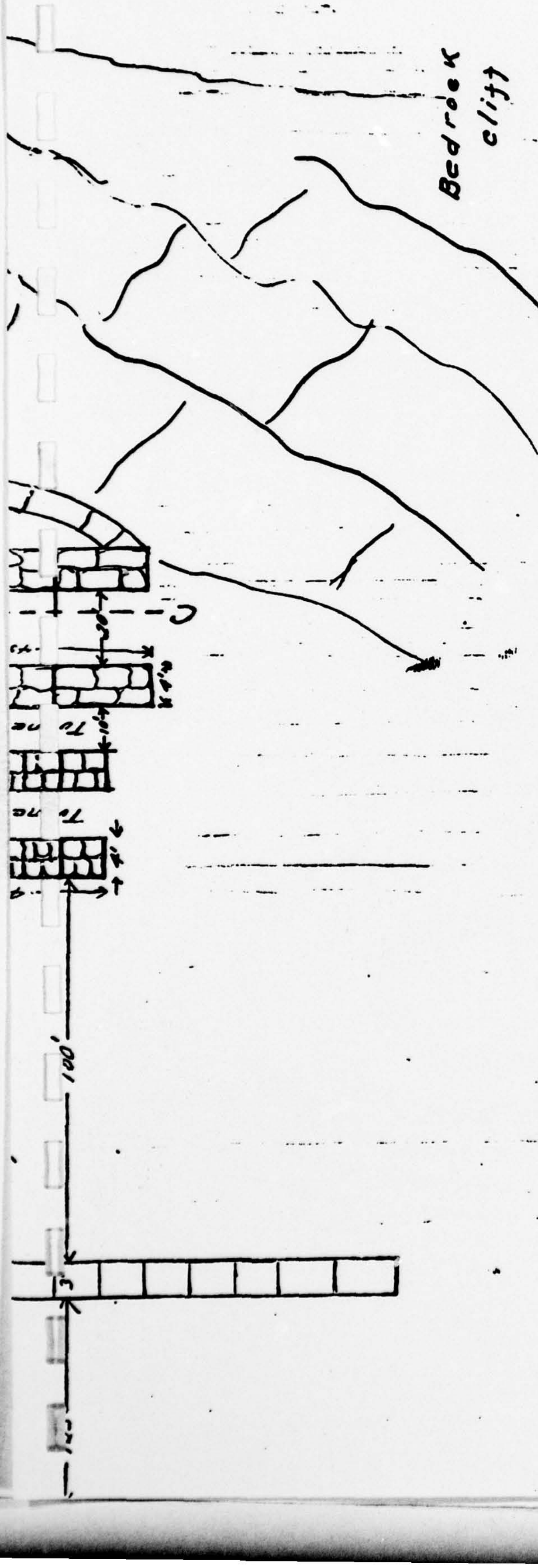


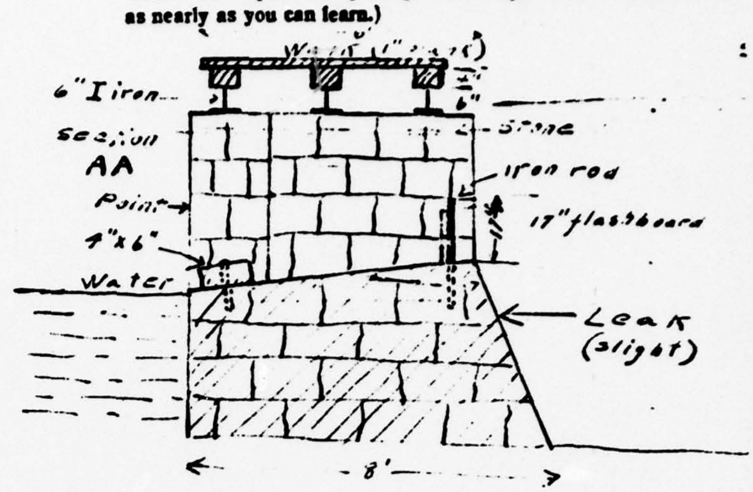
(In the space below, make one sketch showing the form and dimensions of a cross section through the spillway or waste-weir of this dam and outline the abutment, and a second sketch showing the same information for a cross section through the other portion of the dam. Show particularly the greatest height of the dam above the stream bed, its thickness at the top, and thickness at the bottom, as nearly as you can learn.)

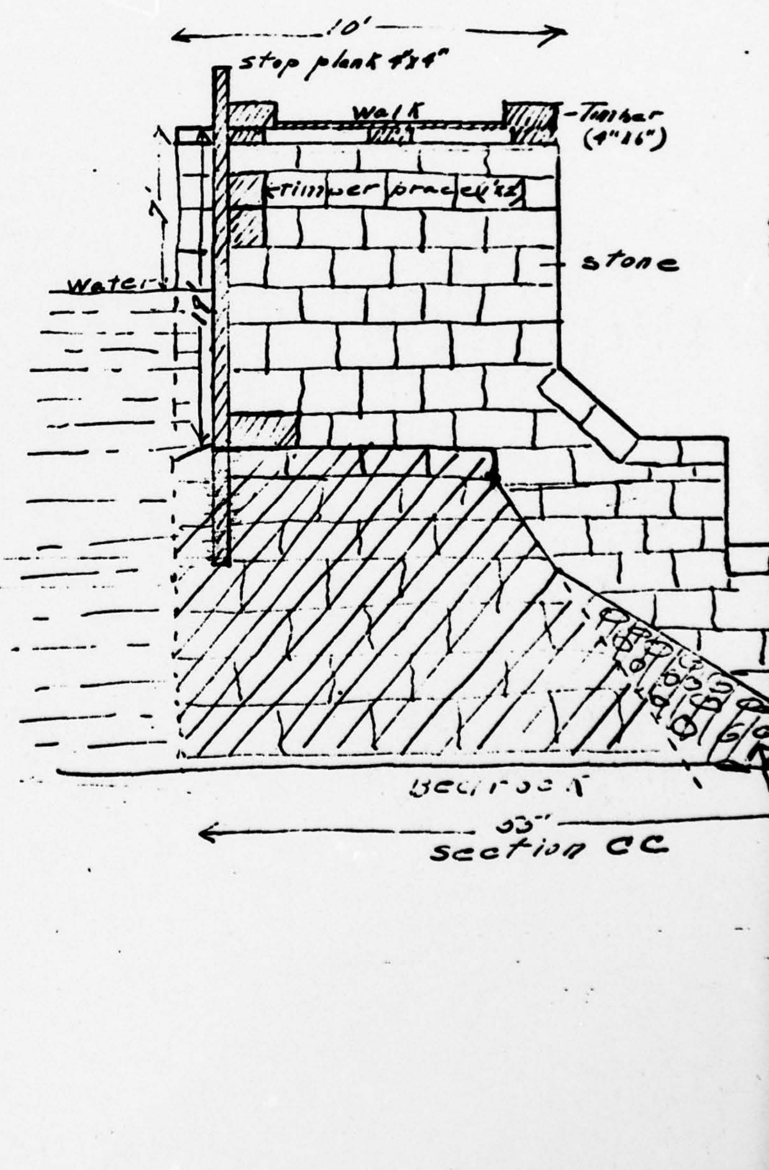


he d n, and its approximate position in relation to buildings or

(In the space below, make one sketch showing the form and dimen dam and outline the abutment, and a second sketch showing the se dam. Show particularly the greatest height of the dam above the as nearly as you can learn.)







The total length of this dam is 110 feet. The spillway or waste-weir portion, is about 110 feet long, and the crest of the spillway is about 6 feet below the abutment.

The number, size and location of discharge pipes, waste pipes or gates which may be used for drawing off the water from behind the dam, are as follows: 2 sluices 20' wide, & one 19' depth & one 7' depth below abutement; 2 discharge tunnels 4' in diameter mechanically operated under gate house.

At the time of this inspection the water level above the dam was ft. 17 in. below ~~above~~ the crest of the spillway. (level with stone portion; 17" of flashboard in.)

(State briefly, in the space below, whether, in your judgment, this dam is in good condition, or bad condition, describing particularly any leaks or cracks or erosions which you may have observed.)

Dam is in very good condition; 1" plank walk from one side to gate house at center is rotted enough to be unsafe; two slight leaks thru masonry as per sketch. Dam going out would undoubtedly cause serious flooding in country along Indian River.
All water getting thru leaks thru stop logs in 19' sluice & thru tunnel gates.

Two or three minor leaks thru masonry abutement might, by freezing & expanding cause trouble.

Reported by Richard V. Oram
(Signature)

Tuxedo Park,
(Address—Street and number, P. O. Box or R. F. D. route)

N. Y.
(Name of place)

Indian Lake [illegible]

10-00-11-3000 (16-10452)

Fill out a form as complete as possible for each dam in your district and send to State Conservation Commission, Albany, N. Y.

1. Name and address of owners Indian River Co., Glens Falls, N.Y.

2. Date of construction 1898

3. Uses of impounded water Champlain Canal, and manufactureing on the Hudson

4. Character of foundation bed Stone,

5. Material of waste spill Stone,

6. Length of waste and depth below dam 106.1/2 ft long and 6 feet deep,

7. Total length of dam including waste About 350 feet then some dirt fill,

8. Material of dam Stone and Cement, and Concrete,

9. Discharges, size and location 2 discharge tunnels 5 feet in diamiter, 1 sluice 15 ft wide and 10 feet deep below waste,

Below sketch section of waste and section of dam, with greatest heights and top thickness and bottom thickness. On opposite side sketch general plan of dam and give distance from a bridge or from a tributary stream.

This dam is situated on the outlet of Indian Lake on township No 15 Town of Indian Lake Hamilton County, N, Y, It is about one mile from any tributary stream and about a mile from a bridge,

It is 47 feet high and 33 feet thick on the bottom and 7 feet thick on the top, the waste way is said to discharge 5.000 Cu. ft per second when the dam is full,

For full discription of this dam see pamplet by

George W. Rafter, Wallace Greenalch and

Robert E. Horton,

Reprinted from Engineering news 1899. *Earth Emb [illegible] paved*

Sep 13-16 N. Side Granite ledge 40' high. S side abutt 2' above main dam [illegible]

[illegible]. 13' below Crest, At High Water Main Dam + abutment evident leak [illegible]

[illegible]. At present 2 small leaks near spill in main dam. Wall pointed [illegible]

[illegible] as far down as water. A R Hall Spill [illegible]

[illegible]

(Signature, address and date.)

January 8th 1912 *R B Nichols*
Indian River N. Y.

Nearest town. *Indian Lake N. Y.*

758

U H

Indian Lake Reservoir

November 25, 1924

Hon. Dwight B. LaDu,
State Engineer,
Albany, N. Y.

Dear Sir:-

I have had an inspection made of the Indian Lake Dam at the outlet of the Indian Lake Reservoir. At the time the inspection was made the water surface in the lake was 14.8 feet below the top of the dam and 17.6 feet below the crest of the spillway, the gage at the dam being 18.8.

There is one place on the dam where seepage shows. This point is located about 10 feet below the present water surface. Between the top of the dam and the water surface cement mortar has broken away from some of the joints of the stone work which undoubtedly allows some water to seep through. This is probably true below the present water surface.

The gage reader states that the dam has always leaked and does not seem to be any worse now than for a considerable time previous. The downstream face of the dam is covered with a crust of material deposited by water seeping through the masonry. A patch of this crust about 6 inches square has broken away, making visible the seepage of the water. This is the spot that is reported as a leak.

While there does not seem to be any cause for alarm I would recommend that when extremely low water occurs in the reservoir, the masonry joints of the upstream face of the dam be pointed up.

In addition to the seepage through the dam, it was observed that there is a masonry pier 4 feet square located about 50 feet above the dam, about opposite the log sluiceway. This masonry pier extends to about gage height 5' and is used as an anchorage for a log boom to direct logs to the sluiceway. This pier has broken apart horizontally at an elevation 17 feet below its top and is tilted toward the dam until the break is open about 2 inches on the upstream side. Repairs should be made by encasing the lower part of this pier in concrete. This also could be accomplished during a low stage of water.

Duplicate

The gate house roof is in a bad state of repair and should be re-shingled.

Sunken stumps and other debris should be cleared away from the gate openings.

I would also recommend that a standard pipe railing be placed along the top of the dam proper as it is necessary for the gage reader to cross this section during high wind storms and when the top of the dam is ice coated and is a dangerous operation. 150 lin. ft. of pipe railing would be required.

Very truly yours,

Division Engineer

E. D. HENDRICKS
DIVISION ENGINEER

STATE OF NEW YORK
DEPARTMENT OF STATE ENGINEER
EASTERN DIVISION
ALBANY

DWIGHT B LA DU
STATE ENGINEER

ARNOLD G. CHAPMAN
DEPUTY

SUBJECT:

Mechanicville, N. Y.,
November 24, 1924.

Indian Lake Dam.

U. H. 758

Mr. E. D. Hendricks,
Division Engineer,
Albany, N. Y.

Dear Sir:-

In accordance with your verbal instructions of recent date, I have visited the Indian Lake Dam and find that there is seepage of water through the masonry section of the dam proper.

The water surface in the lake was 24.8' below the top of the dam, or about 17.6' below the spillway, or at gage height 15.8'. I estimate that there is about 10' head of water above the spot where seepage shows up on the lower side of the dam. Between the top of the dam and the water surface the cement mortar seems to have broken away from between the joints of the stone work, allowing some water to seep through. This is probably also true below the water surface.

Mr. Frank Brown, of Indian Lake, N. Y., who takes the gage records, informs me that the dam has always leaked, but does not seem to get any worse. This is borne out by the fact that the downstream surface of the dam is covered with a crust of material deposited by water seeping through the masonry. A patch of this crest, about 6' square, has broken away and a small amount of water appears. This is what has been reported as a leak.

Pointing up the masonry on the lake side when the water might be drawn down to, say, 10' below, where it is at present (gage height, 15.8'), would probably stop or materially reduce the seepage.

About 30 ft. above the dam and about opposite of the log sluiceway there is a masonry pier about 4 ft. square, extending to about gage height 35.0, which is used as an anchor for a log boom to direct logs to the sluiceway. This has broken apart horizontally at about gage height 18.0

and has tilted toward the dam until the break is opened about 2-inches on the upstream side. Repairs could be made by encasing the lower part of the pier in concrete. This also could best be accomplished during a low stage of water.

The gate-house roof is in quite a bad state of repairs and should be reshingled.

Sunken stumps and other debris should be cleared away from the gate openings.

A standard iron pipe railing should be placed along the top of the dam proper (say, 150 lin.ft.), as it is necessary for the gage reader to traverse this section during high wind storms and when top of dam is ice coated.

Very truly yours,

H. L. Clarke
....
Assistant Engineer.

APPENDIX C

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

STETSON • DALE BANKERS TRUST BUILDING UTICA • NEW YORK • 13501 TEL 315-797-5800 DESIGN BRIEF

PROJECT NAME NY DAM INSPECTION DATE 9.14.78

SUBJECT INDIAN LAKE DAM PROJECT NO. 2210

DRAWN BY JPG

ESTIMATE OF CLARK'S PARAMETERS

ESTIMATE OF T_C

$$T_C = 11.9\,(L^3/H)^{.385} = (11.9\,(25.71)^3/1950)^{.385} = 5.972 \text{ HRS}$$

SCS

$$L = \frac{\ell^{.8}\,(S+1)^{.7}}{1900\,Y^{.5}} = \frac{(135750)^{.8}\,(3.89+1)^{.7}}{1900\,(140)^{.5}} \qquad S = \frac{1000}{CN} - 10 = 3.89$$

$$= \frac{38788.95}{7109.15} = 5.456$$

$$T_C = L/.6 = 9.094 \text{ HRS}$$

STETSON • DALE BANKERS TRUST BUILDING UTICA • NEW YORK • 13501 TEL 315-797-5800 **DESIGN BRIEF**

PROJECT NAME: NY DAM INSPECTION DATE: 9·15·78

SUBJECT: INDIAN LAKE DAM PROJECT NO. 2210

DRAWN BY: JPG

ESTIMATE OF SNYDER'S PARAMETERS

640 $C_p =$

$C_p = .625$

$C_t = 2.0$

$t_p = C_t \, (L \cdot L_{ca})^{.3} =$

$= 2.0 \, (25.71 \times 12.33)^{.3}$

$= 11.255$

$t_r = t_p / 5.5 = 11.255 / 5.5 = 2.046$

$t_{pr} = t_p + .25 \, (t_R - t_r)$

$= 11.255 + .25 \, (3.0 - 2.046) = 11.49$

SUMMARY OF PARAMETERS

CLARK'S

BPR $T_c = 5.972$

SCS (CN METHOD) $T_c = 9.094$

SNYDER'S

$C_p = .625$

$t_{pr} = 11.49$

STETSON • DALE BANKERS TRUST BUILDING UTICA • NEW YORK • 13501 TEL 315-797-5800 **DESIGN BRIEF**

PROJECT NAME NY DAM INSPECTION DATE 9·19·78

SUBJECT INDIAN LAKE DAM PROJECT NO. 2210

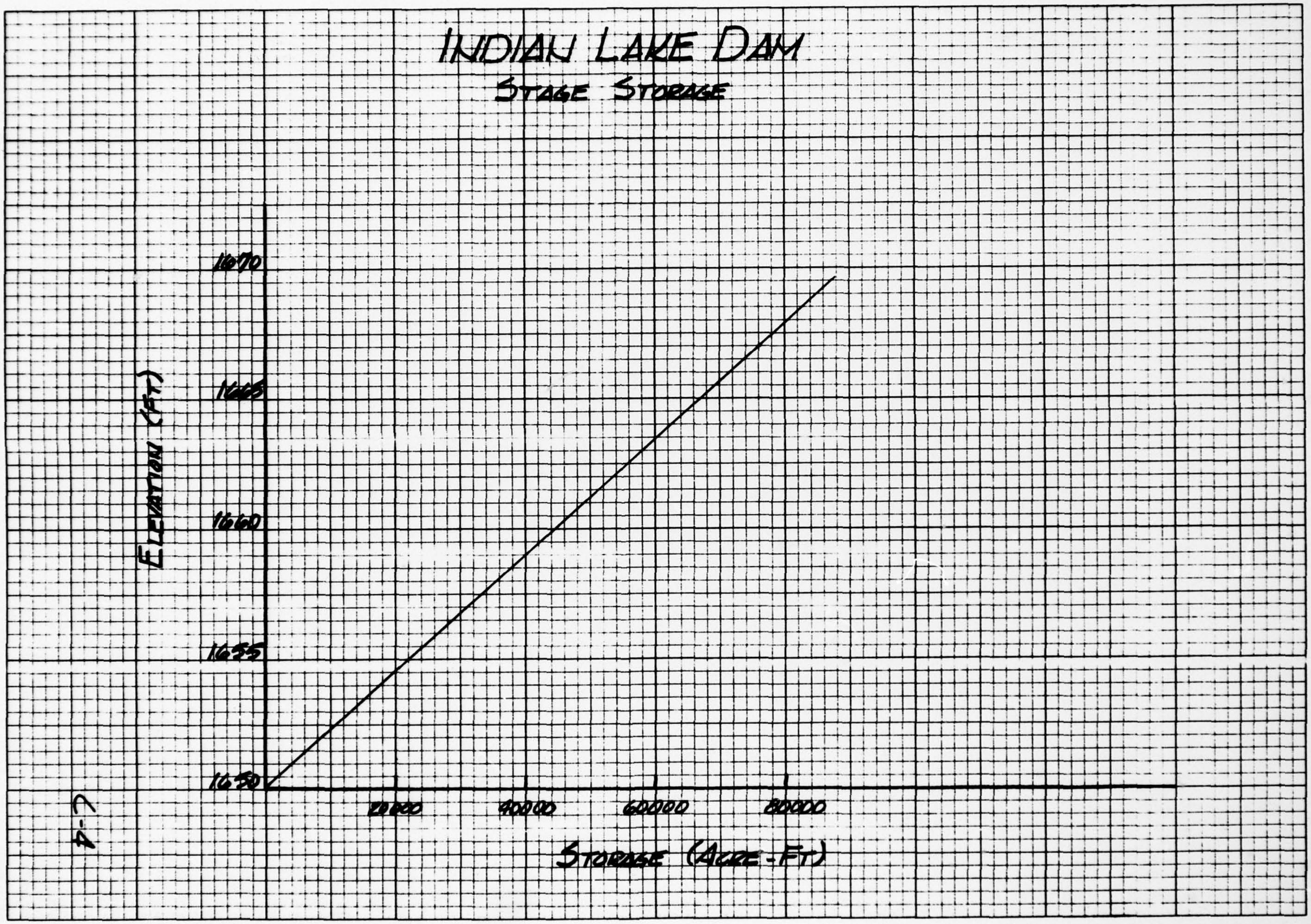
DRAWN BY JPG

HYDROMETEOROLOGICAL REPORT Nº 33

PMP INDEX RAINFALL

24 HR, 200 MI² - 17.5"

DURATION	%	DEPTH
6 HR	89	15.58
12 HR	101	17.68
24 HR	112	19.60
48 HR	118	20.65


INDIAN LAKE DAM
STAGE STORAGE
ELEVATION (FT)
1670
1665
1660
1655
1650
20000
40000
60000
80000
STORAGE (ACRE-FT)

STETSON • DALE BANKERS TRUST BUILDING UTICA • NEW YORK • 13501 TEL 315-797-5800 DESIGN BRIEF

PROJECT NAME NY DAM INSPECTION DATE 9.18.78

SUBJECT INDIAN LAKE DAM PROJECT NO. 2210

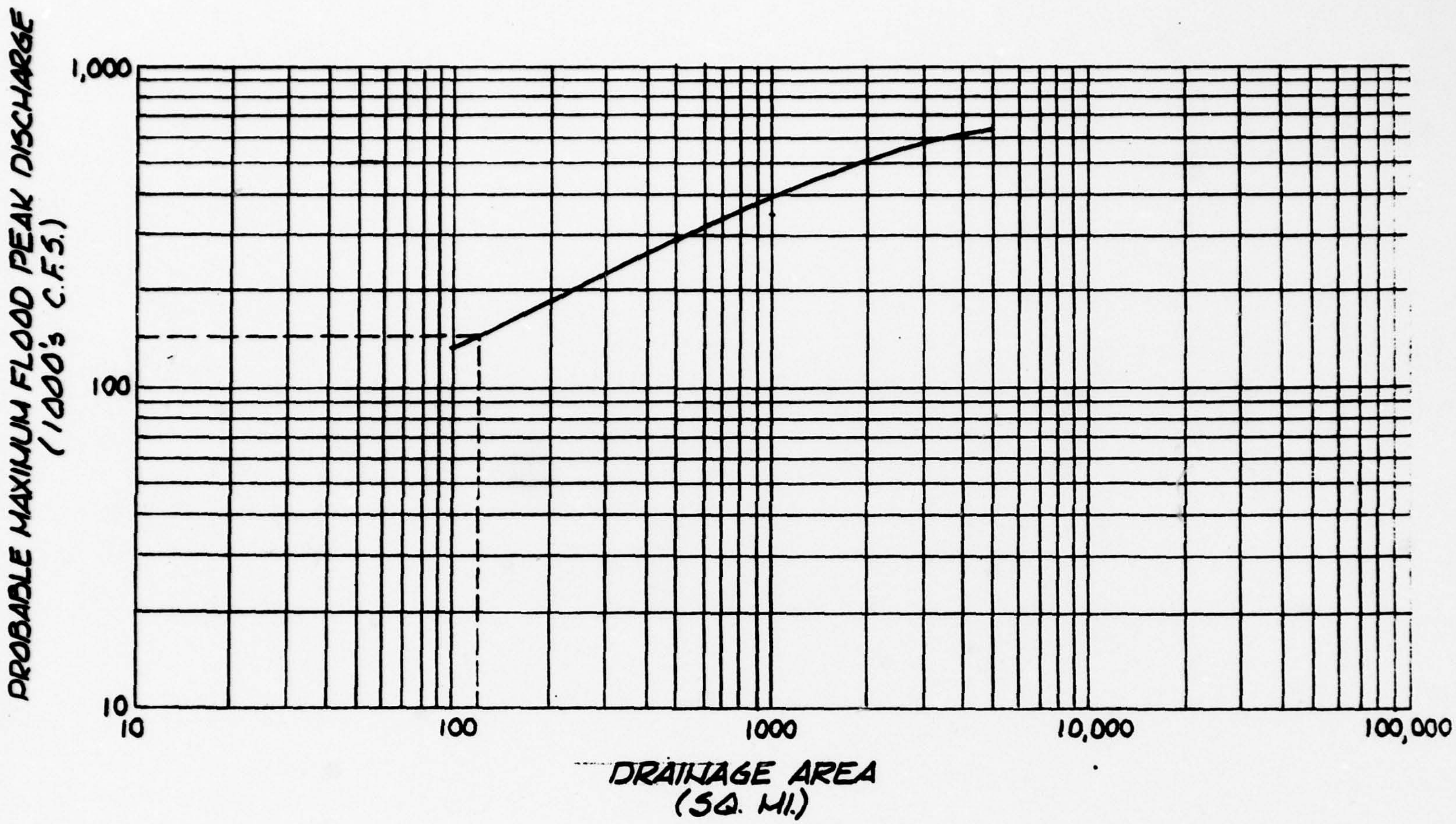
DRAWN BY JPG

STAGE - DISCHARGE (FROM CREST OF SPILLWAY)

ELEV	Q PRINCIPAL SPILLWAY	Q DAM	Q TOTAL
1650	—	—	—
1651	336	—	336
1652	950	—	950
1653	1746	—	1746
1654	2688	—	2688
1655	3757	—	3757
1656	4938	—	4938
1657	6223	—	6223
1658	7603	1000	8603
1659	9072	2828	11900
1660	10625	5196	15821
1661	12258	8000	20258
1662	13967	11180	25147
1663	15749	14697	30446
1664	17600	18520	36120
1665	19520	22627	42147

L = 105

C = 3.2



INDIAN LAKE DAM

ESTIMATE OF PROBABLE MAXIMUM FLOOD USING
NUCLEAR REGULATORY COMMISSION CURVES

STETSON • DALE

DATE	DRAWN	
9.15.78	JPG	C-6
JOB	APP'D	
2210		

```
00100 A   INDIAN LAKE DAM
0110 A RESERVOIR ROUTING OF P.M.F. - CLARK METHOD
0120 A  UNCONTROLLED SPILLWAY ONLY
0130 B     90       1
0140 1      5
0150 J      1       9       1
0160 1     .1      .2      .3      .4      .5      .6      .7      .8     1.0
0170 K      0       1
0180 M      1       0     122       0     122                              1
0190 P      0    17.5      89     101     112     118
0200 T                                                    1.0     0.1
0210 W   9.09    9.09
0220 X    244     244       1
0230 K      1       1
0240 Y                              1       1
0250 1      1                                              -1
0260 2      0    8900   17800   26700   35600   44500   53400   62300   66750
0270 3      0     950    2688    4938    8603   15821   25147   36120   42147
0280 K     99
0290 A
00300 A
0310 A
0320 A
0330 A
```

```
00100 A   INDIAN LAKE DAM
0110 A RESERVOIR ROUTING OF P.M.F. - SNYDER METHOD
0120 A  UNCONTROLLED SPILLWAY ONLY
0130 B     90       1
0140 1      5
0150 J      1       9       1
0160 1     .1      .2      .3      .4      .5      .6      .7      .8     1.0
0170 K      0       1
0180 M      1       1     122       0     122                              1
0190 P      0    17.5      89     101     112     118
0200 T                                                    1.0     0.1
0210 V   11.5   0.625
0220 X    244     244       1
0230 K      1       1
0240 Y                              1       1
0250 1      1                                              -1
0260 2      0    8900   17800   26700   35600   44500   53400   62300   66750
0270 3      0     950    2688    4938    8603   15821   25147   36120   42147
0280 K     99
0290 A
00300 A
0310 A
0320 A
0330 A
```

```
PDATED AUG 74
ANGE NO. 01
**************************

**************************
C-1 VERSION DATED JAN 1973
PDATED AUG 74
ANGE NO. 01
**************************
              INDIAN LAKE DAM
            RESERVOIR ROUTING OF P.M.F. - CLARK METHOD
             UNCONTROLLED SPILLWAY ONLY

                                JOB SPECIFICATION
                    NQ   NHR  NMIN  IDAY   IHR  IMIN METRC  IPLT  IPRT NSTAN
                    90     1     0     0     0     0     0     0     0     0
                                  JOPER   NWT
                                      5     0

                         MULTI-PLAN ANALYSES TO BE PERFORMED
                           NPLAN= 1 NRTIO= 9 LRTIO= 1
           RTIOS=  0.10  0.20  0.30  0.40  0.50  0.60  0.70  0.80  1.00


       **********       **********       **********       **********       **********

                          SUB-AREA RUNOFF COMPUTATION
                     ISTAQ  ICOMP  IECON  ITAPE   JPLT   JPRT  INAME
                         1      0      0      0      0      0      0

                                HYDROGRAPH DATA
         IHYDG   IUHG   TAREA    SNAP  TRSDA  TRSPC  RATIO  ISNOW  ISAME  LOCAL
             1      0  122.00    0.0  122.00    0.0    0.0      0      1      0

                                  PRECIP DATA
                    SPFE    PMS     R6    R12    R24    R48    R72    R96
                     0.0  17.50  89.00 101.00 112.00 118.00    0.0    0.0
RSPC COMPUTED BY THE PROGRAM IS 0.872

                                   LOSS DATA
        STRKR  DLTKR  RTIOL  ERAIN  STRKS  RTIOK  STRTL  CNSTL  ALSMX  RTIMP
          0.0    0.0   1.00    0.0    0.0   1.00   1.00   0.10    0.0    0.0

                              UNIT HYDROGRAPH DATA
                           TC= 9.09    R= 9.09    NTA= 0

                                 RECESSION DATA
                     STRTQ= 244.00   QRCSN= 244.00   RTIOR= 1.00

          UNIT HYDROGRAPH 53 END-OF-PERIOD ORDINATES, LAG=  8.23 HOURS, CP= 0.57  VOL= 1.00
     212.     788.    1595.    2523.    3512.    4404.    5057.    5438.    5505.    5172.
    4639.    4155.    3722.    3334.    2986.    2675.    2396.    2146.    1922.    1722.
    1542.    1381.    1237.    1108.     993.     889.     796.     713.     639.     572.
     513.     459.     411.     368.     330.     296.     265.     237.     212.     190.
     170.     153.     137.     123.     110.      98.      88.      79.      71.      63.
      57.      51.      45.

                              END-OF-PERIOD FLOW
                          TIME   RAIN   EXCS    COMP Q
                             1   0.01   0.00      244.
                             2   0.01   0.00      244.
                             3   0.01   0.00      244.
                             4   0.01   0.00      244.
```

6	0.01	0.00	244.
7	0.02	0.00	244.
8	0.02	0.00	244.
9	0.02	0.00	244.
10	0.02	0.00	244.
11	0.02	0.00	244.
12	0.02	0.00	244.
13	0.07	0.00	244.
14	0.09	0.00	244.
15	0.11	0.00	244.
16	0.28	0.00	244.
17	0.10	0.00	244.
18	0.08	0.00	244.
19	0.01	0.00	244.
20	0.01	0.00	244.
21	0.01	0.00	244.
22	0.01	0.00	244.
23	0.01	0.00	244.
24	0.01	0.00	244.
25	0.11	0.00	245.
26	0.11	0.01	249.
27	0.11	0.01	260.
28	0.11	0.01	282.
29	0.11	0.01	315.
30	0.11	0.01	359.
31	0.31	0.21	454.
32	0.31	0.21	667.
33	0.31	0.21	1040.
34	0.31	0.21	1592.
35	0.31	0.21	2330.
36	0.31	0.21	3235.
37	1.36	1.26	4482.
38	1.63	1.53	6463.
39	2.04	1.94	9544.
40	5.16	5.06	14648.
41	1.90	1.80	22377.
42	1.49	1.39	32148.
43	0.17	0.07	42920.
44	0.17	0.07	53526.
45	0.17	0.07	62622.
46	0.17	0.07	68974.
47	0.17	0.07	72038.
48	0.17	0.07	71778.
49	0.0	0.0	68377.
50	0.0	0.0	63060.
51	0.0	0.0	57280.
52	0.0	0.0	51707.
53	0.0	0.0	46623.
54	0.0	0.0	41983.
55	0.0	0.0	37752.
56	0.0	0.0	33901.
57	0.0	0.0	30408.
58	0.0	0.0	27263.
59	0.0	0.0	24445.
60	0.0	0.0	21922.
61	0.0	0.0	19661.
62	0.0	0.0	17637.
63	0.0	0.0	15823.
64	0.0	0.0	14198.
65	0.0	0.0	12743.
66	0.0	0.0	11440.
67	0.0	0.0	10273.
68	0.0	0.0	9227.
69	0.0	0.0	8290.
70	0.0	0.0	7451.

72	0.0	0.0	6026.
73	0.0	0.0	5423.
74	0.0	0.0	4883.
75	0.0	0.0	4400.
76	0.0	0.0	3966.
77	0.0	0.0	3578.
78	0.0	0.0	3230.
79	0.0	0.0	2918.
80	0.0	0.0	2639.
81	0.0	0.0	2389.
82	0.0	0.0	2165.
83	0.0	0.0	1964.
84	0.0	0.0	1776.
85	0.0	0.0	1608.
86	0.0	0.0	1458.
87	0.0	0.0	1323.
88	0.0	0.0	1202.
89	0.0	0.0	1094.
90	0.0	0.0	954.
SUM	18.09	14.71	1169564.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	72038.	67808.	41620.	16183.	1169550.
INCHES		5.17	12.69	14.81	14.86
AC-FT		33641.	82594.	96344.	96707.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	25.	26.	28.	31.	36.
45.	67.	104.	159.	233.	323.	448.	646.	954.	1465.
2238.	3215.	4292.	5353.	6262.	6897.	7204.	7178.	6838.	6306.
5728.	5171.	4662.	4198.	3775.	3390.	3041.	2726.	2445.	2192.
1966.	1764.	1582.	1420.	1274.	1144.	1027.	923.	829.	745.
670.	603.	542.	488.	440.	397.	358.	323.	292.	264.
239.	216.	196.	178.	161.	146.	132.	120.	109.	95.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7204.	6781.	4162.	1618.	116955.
INCHES		0.52	1.27	1.48	1.49
AC-FT		3364.	8259.	9634.	9671.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

49.	49.	49.	49.	49.	49.	49.	49.	49.	49.
49.	49.	49.	49.	49.	49.	49.	49.	49.	49.
49.	49.	49.	49.	49.	50.	52.	56.	63.	72.
91.	133.	208.	318.	466.	647.	896.	1293.	1909.	2930.
4475.	6430.	8584.	10705.	12524.	13795.	14408.	14356.	13675.	12612.
11456.	10341.	9325.	8397.	7550.	6780.	6082.	5453.	4889.	4384.
3932.	3527.	3165.	2840.	2549.	2288.	2055.	1845.	1658.	1490.
1340.	1205.	1085.	977.	880.	793.	716.	646.	584.	528.
478.	433.	393.	355.	322.	292.	265.	240.	219.	191.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	14408.	13562.	8324.	3237.	233912.
INCHES		1.03	2.54	2.96	2.97
AC-FT		6728.	16519.	19269.	19341.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

73.	73.	73.	73.	73.	73.	73.	73.	73.	73.
73.	73.	73.	73.	73.	73.	73.	73.	73.	73.
73.	73.	73.	73.	73.	75.	78.	85.	94.	108.
136.	200.	312.	478.	699.	970.	1345.	1939.	2863.	4394.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

5898.	5291.	4747.	4260.	3823.	3432.	3082.	2768.	2487.	2235.
2010.	1808.	1627.	1465.	1320.	1190.	1073.	969.	876.	792.
717.	649.	589.	533.	482.	437.	397.	361.	328.	286.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	21611.	20342.	12486.	4855.	350867.
INCHES		1.55	3.81	4.44	4.46
AC-FT		10092.	24778.	28903.	29012.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

98.	98.	98.	98.	98.	98.	98.	98.	98.	98.
98.	98.	98.	98.	98.	98.	98.	98.	98.	98.
98.	98.	98.	98.	98.	100.	104.	113.	126.	144.
182.	267.	416.	637.	932.	1294.	1793.	2585.	3818.	5859.
8951.	12859.	17168.	21410.	25049.	27589.	28815.	28711.	27351.	25224.
22912.	20683.	18649.	16793.	15101.	13560.	12163.	10905.	9778.	8769.
7865.	7055.	6329.	5679.	5097.	4576.	4109.	3691.	3316.	2980.
2680.	2411.	2169.	1953.	1760.	1587.	1431.	1292.	1167.	1056.
956.	866.	786.	711.	643.	583.	529.	481.	437.	382.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	28815.	27123.	16648.	6473.	467824.
INCHES		2.07	5.08	5.92	5.95
AC-FT		13456.	33038.	38538.	38683.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

122.	122.	122.	122.	122.	122.	122.	122.	122.	122.
122.	122.	122.	122.	122.	122.	122.	122.	122.	122.
122.	122.	122.	122.	122.	124.	130.	141.	157.	179.
227.	334.	520.	796.	1165.	1617.	2241.	3232.	4772.	7324.
11189.	16074.	21460.	26763.	31311.	34487.	36019.	35889.	34188.	31530.
28640.	25854.	23311.	20992.	18876.	16950.	15204.	13631.	12223.	10961.
9831.	8818.	7911.	7099.	6372.	5720.	5136.	4613.	4145.	3726.
3350.	3013.	2712.	2442.	2200.	1983.	1789.	1615.	1459.	1320.
1194.	1082.	982.	888.	804.	729.	661.	601.	547.	477.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	36019.	33904.	20810.	8091.	584780.
INCHES		2.59	6.35	7.40	7.43
AC-FT		16821.	41297.	48172.	48354.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 6

146.	146.	146.	146.	146.	146.	146.	146.	146.	146.
146.	146.	146.	146.	146.	146.	146.	146.	146.	146.
146.	146.	146.	146.	147.	149.	156.	169.	189.	215.
272.	400.	624.	955.	1398.	1941.	2689.	3878.	5726.	8789.
13426.	19289.	25752.	32115.	37573.	41384.	43223.	43067.	41026.	37836.
34368.	31024.	27974.	25190.	22651.	20340.	18245.	16358.	14667.	13153.
11797.	10582.	9494.	8519.	7646.	6864.	6164.	5536.	4974.	4471.
4020.	3616.	3254.	2930.	2640.	2380.	2147.	1938.	1751.	1583.
1433.	1299.	1178.	1066.	965.	875.	794.	721.	656.	572.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	43223.	40685.	24972.	9710.	701736.
INCHES		3.10	7.62	8.88	8.92
AC-FT		20185.	49556.	57807.	58025.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 7

171.	171.	171.	171.	171.	171.	171.	171.	171.	171.
171.	171.	171.	171.	171.	171.	171.	171.	171.	171.
171.	171.	171.	171.	171.	174.	182.	197.	220.	251.
318.	467.	728.	1114.	1631.	2264.	3138.	4524.	6681.	10254.
15664.	22503.	30044.	37468.	43836.	48281.	50426.	50245.	47864.	44142.
40096.	36195.	32636.	29388.	26426.	23730.	21285.	19084.	17112.	15345.
13763.	12346.	11076.	9939.	8920.	8008.	7191.	6459.	5802.	5214.

1672.	1515.	1375.	1243.	1126.	1020.	926.	841.	766.	660.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	50426.	47466.	29134.	11328.	818691.
INCHES		3.62	8.89	10.36	10.40
AC-FT		23549.	57816.	67441.	67695.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 8

195.	195.	195.	195.	195.	195.	195.	195.	195.	195.
195.	195.	195.	195.	195.	195.	195.	195.	195.	195.
195.	195.	195.	195.	196.	199.	208.	226.	252.	287.
363.	534.	832.	1273.	1864.	2588.	3586.	5171.	7635.	11718.
17902.	25718.	34336.	42821.	50098.	55179.	57630.	57422.	54702.	50448.
45824.	41366.	37298.	33586.	30202.	27120.	24326.	21810.	19556.	17537.
15729.	14109.	12658.	11359.	10195.	9152.	8218.	7381.	6632.	5961.
5360.	4821.	4339.	3907.	3520.	3173.	2862.	2584.	2335.	2111.
1911.	1732.	1571.	1421.	1286.	1166.	1058.	961.	875.	763.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	57630.	54246.	33296.	12946.	935647.
INCHES		4.14	10.15	11.85	11.89
AC-FT		26913.	66075.	77075.	77366.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 9

244.	244.	244.	244.	244.	244.	244.	244.	244.	244.
244.	244.	244.	244.	244.	244.	244.	244.	244.	244.
244.	244.	244.	244.	245.	249.	260.	282.	315.	359.
454.	667.	1040.	1592.	2330.	3234.	4482.	6463.	9544.	14648.
22377.	32148.	42920.	53526.	62622.	68973.	72038.	71778.	68377.	63060.
57280.	51707.	46623.	41983.	37752.	33901.	30408.	27263.	24445.	21922.
19661.	17637.	15823.	14198.	12743.	11440.	10272.	9227.	8290.	7451.
6700.	6026.	5423.	4883.	4400.	3966.	3578.	3230.	2918.	2639.
2389.	2165.	1964.	1776.	1600.	1458.	1323.	1202.	1094.	954.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	72038.	67800.	41620.	16183.	1169547.
INCHES		5.17	12.69	14.81	14.86
AC-FT		33641.	82594.	96343.	96707.

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HYDROGRAPH ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	1	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	1

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.0	0.0	0.0	-1.

STORAGE=	0.	8900.	17800.	26700.	35600.	44500.	53400.	62300.	66750.	0.
OUTFLOW=	0.	950.	2688.	4938.	8603.	15821.	25147.	36120.	42147.	0.

STATION 1, PLAN 1, RTIO 1

24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	25.
25.	25.	26.	26.	28.	30.	33.	38.	44.	55.
70.	94.	126.	167.	217.	273.	332.	392.	450.	504.
553.	596.	634.	667.	696.	721.	743.	762.	778.	792.
803.	812.	820.	826.	830.	834.	836.	837.	838.	837.
836.	834.	832.	829.	826.	822.	818.	814.	810.	805.

STOR

229.	229.	229.	229.	229.	229.	229.	229.	229.	229.
229.	229.	229.	229.	229.	229.	229.	229.	229.	229.
229.	229.	229.	229.	229.	229.	229.	229.	229.	230.
231.	234.	239.	248.	262.	282.	312.	354.	417.	512.
660.	879.	1180.	1566.	2030.	$2554.	3112.	3676.	4220.	4724.
5178.	5581.	5936.	6248.	6522.	6759.	6964.	7140.	7290.	7417.
7523.	7610.	7681.	7737.	7780.	7811.	7832.	7843.	7847.	7842.
7832.	7815.	7794.	7768.	7738.	7704.	7668.	7628.	7587.	7543.
7497.	7450.	7402.	7352.	7301.	7250.	7198.	7145.	7091.	7038.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	838.	836.	820.	479.	34893.
INCHES		0.06	0.25	0.44	0.44
AC-FT		415.	1627.	2849.	2885.

STATION 1, PLAN 1, RTIO 2

49.	49.	49.	49.	49.	49.	49.	49.	49.	49.
49.	49.	49.	49.	49.	49.	49.	49.	49.	49.
49.	49.	49.	49.	49.	49.	49.	49.	49.	49.
49.	50.	51.	53.	56.	60.	67.	76.	89.	109.
141.	188.	252.	334.	433.	545.	664.	785.	901.	1057.
1232.	1387.	1522.	1640.	1741.	1828.	1902.	1964.	2015.	2057.
2091.	2117.	2137.	2150.	2159.	2163.	2163.	2160.	2153.	2144.
2132.	2119.	2103.	2086.	2067.	2048.	2027.	2005.	1983.	1960.
1937.	1913.	1889.	1865.	1841.	1816.	1791.	1767.	1742.	1717.

STOR

457.	457.	457.	457.	457.	457.	457.	457.	457.	457.
457.	457.	457.	457.	457.	457.	457.	457.	457.	457.
457.	457.	457.	457.	457.	457.	457.	458.	459.	460.
463.	468.	478.	495.	523.	565.	623.	708.	833.	1025.
1321.	1758.	2360.	3133.	4061.	5108.	6223.	7352.	8441.	9446.
10346.	11138.	11831.	12432.	12952.	13396.	13774.	14091.	14354.	14569.
14741.	14875.	14976.	15047.	15091.	15113.	15113.	15096.	15062.	15015.
14955.	14885.	14805.	14717.	14622.	14521.	14415.	14305.	14191.	14074.
13954.	13833.	13710.	13585.	13460.	13335.	13208.	13082.	12956.	12830.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2163.	2158.	2081.	1168.	84960.
INCHES		0.16	0.63	1.07	1.08
AC-FT		1071.	4129.	6952.	7025.

STATION 1, PLAN 1, RTIO 3

73.	73.	73.	73.	73.	73.	73.	73.	73.	73.
73.	73.	73.	73.	73.	73.	73.	73.	73.	73.
73.	73.	73.	73.	73.	73.	73.	73.	73.	74.
74.	75.	77.	79.	84.	90.	100.	113.	133.	164.
211.	281.	378.	502.	650.	818.	1035.	1363.	1678.	1967.
2224.	2451.	2647.	2856.	3044.	3203.	3337.	3446.	3536.	3606.
3661.	3701.	3728.	3744.	3750.	3748.	3737.	3721.	3698.	3670.
3638.	3603.	3564.	3522.	3478.	3432.	3384.	3335.	3286.	3235.
3184.	3132.	3080.	3028.	2976.	2924.	2872.	2820.	2769.	2718.

STOR

686.	686.	686.	686.	686.	686.	686.	686.	686.	686.
686.	686.	686.	686.	686.	686.	686.	686.	686.	686.
686.	686.	686.	686.	686.	686.	686.	687.	688.	690.
694.	702.	717.	743.	785.	847.	935.	1062.	1250.	1537.
1981.	2636.	3540.	4699.	6091.	7662.	9333.	11017.	12629.	14108.
15426.	16504.	17593.	18464.	19208.	19838.	20365.	20800.	21152.	21432.
21647.	21805.	21913.	21977.	22001.	21991.	21951.	21884.	21795.	21686.
21559.	21418.	21263.	21098.	20924.	20742.	20554.	20361.	20164.	19963.
19760.	[illegible]	19350.	19144.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

C-13

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3750.	3738.	3565.	1976.	143555.
INCHES		0.29	1.09	1.81	1.82
AC-FT		1854.	7074.	11761.	11870.

STATION 1, PLAN 1, RTIO 4

98.	98.	98.	98.	98.	98.	98.	98.	98.	98.
98.	98.	98.	98.	98.	98.	98.	98.	98.	98.
98.	98.	98.	98.	98.	98.	98.	98.	98.	98.
99.	100.	102.	106.	112.	121.	133.	151.	178.	219.
282.	375.	504.	669.	867.	1206.	1638.	2073.	2488.	2922.
3359.	3740.	4070.	4352.	4592.	4793.	4974.	5193.	5365.	5496.
5590.	5653.	5688.	5698.	5688.	5660.	5615.	5558.	5489.	5411.
5325.	5232.	5133.	5030.	4929.	4862.	4793.	4722.	4650.	4576.
4503.	4428.	4354.	4279.	4205.	4131.	4057.	3983.	3910.	3838.

STOR

914.	914.	914.	914.	914.	914.	914.	914.	914.	914.
914.	914.	914.	914.	914.	914.	914.	914.	914.	914.
914.	914.	914.	914.	914.	914.	915.	916.	917.	920.
926.	936.	956.	991.	1047.	1129.	1246.	1415.	1666.	2050.
2641.	3515.	4720.	6265.	8122.	10211.	12424.	14648.	16776.	18725.
20455.	21963.	23265.	24382.	25330.	26127.	26786.	27319.	27738.	28055.
28284.	28436.	28521.	28547.	28521.	28452.	28345.	28206.	28039.	27848.
27639.	27413.	27174.	26924.	26666.	26400.	26125.	25845.	25559.	25270.
24978.	24684.	24389.	24094.	23800.	23506.	23214.	22923.	22635.	22349.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5698.	5667.	5273.	2895.	210195.
INCHES		0.43	1.61	2.65	2.67
AC-FT		2812.	10464.	17235.	17380.

STATION 1, PLAN 1, RTIO 5

122.	122.	122.	122.	122.	122.	122.	122.	122.	122.
122.	122.	122.	122.	122.	122.	122.	122.	122.	122.
122.	122.	122.	122.	122.	122.	122.	122.	122.	123.
124.	125.	128.	132.	140.	151.	166.	189.	222.	273.
352.	469.	630.	836.	1194.	1701.	2238.	2804.	3471.	4079.
4616.	5175.	5824.	6371.	6824.	7196.	7493.	7724.	7899.	8022.
8102.	8142.	8150.	8128.	8082.	8014.	7927.	7825.	7710.	7583.
7448.	7305.	7157.	7003.	6847.	6687.	6527.	6365.	6204.	6043.
5882.	5724.	5567.	5412.	5259.	5109.	4961.	4863.	4774.	4686.

STOR

1143.	1143.	1143.	1143.	1143.	1143.	1143.	1143.	1143.	1143.
1143.	1143.	1143.	1143.	1143.	1143.	1143.	1143.	1143.	1143.
1143.	1143.	1143.	1143.	1143.	1143.	1143.	1145.	1147.	1151.
1157.	1170.	1195.	1239.	1308.	1411.	1558.	1769.	2083.	2562.
3301.	4394.	5900.	7832.	10148.	12747.	15498.	18261.	20897.	23301.
25428.	27275.	28852.	30179.	31281.	32182.	32904.	33467.	33889.	34189.
34382.	34482.	34500.	34447.	34334.	34169.	33959.	33711.	33431.	33124.
32795.	32448.	32087.	31715.	31335.	30948.	30558.	30166.	29774.	29382.
28994.	28608.	28227.	27850.	27479.	27114.	26756.	26402.	26051.	25702.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8150.	8104.	7507.	3993.	289711.
INCHES		0.62	2.29	3.65	3.68
AC-FT		4021.	14897.	23774.	23955.

STATION 1, PLAN 1, RTIO 6

146.	146.	146.	146.	146.	146.	146.	146.	146.	146.
146.	146.	146.	146.	146.	146.	146.	146.	146.	146.
146.	146.	146.	146.	146.	146.	146.	147.	147.	147.
148.	150.	153.	159.	168.	181.	200.	227.	267.	328.
423.	563.	756.	1047.	1588.	2195.	[illegible]	3713.	[illegible]	[illegible]

11909.	11862.	11744.	11566.	11340.	11075.	10780.	10460.	10122.	9772.
9414.	9051.	8687.	8459.	8269.	8076.	7882.	7686.	7491.	7296.
7102.	6910.	6721.	6533.	6349.	6167.	5988.	5813.	5642.	5474.

STOR

1372.	1372.	1372.	1372.	1372.	1372.	1372.	1372.	1372.	1372.
1372.	1372.	1372.	1372.	1372.	1372.	1372.	1372.	1372.	1372.
1372.	1372.	1372.	1372.	1372.	1372.	1372.	1374.	1376.	1381.
1389.	1404.	1434.	1486.	1570.	1694.	1869.	2123.	2499.	3075.
3962.	5273.	7079.	9396.	12167.	15273.	18560.	21853.	24988.	27838.
30332.	32466.	34269.	35772.	36985.	37927.	38630.	39129.	39453.	39628.
39676.	39618.	39473.	39254.	38975.	38648.	38284.	37889.	37473.	37041.
36600.	36152.	35703.	35250.	34789.	34321.	33849.	33374.	32899.	32426.
31956.	31490.	31029.	30574.	30125.	29684.	29251.	28826.	28409.	28001.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	11909.	11780.	10238.	5269.	381971.
INCHES		0.90	3.12	4.82	4.85
AC-FT		5844.	20318.	31366.	31584.

STATION 1, PLAN 1, RTIO 7

171.	171.	171.	171.	171.	171.	171.	171.	171.	171.
171.	171.	171.	171.	171.	171.	171.	171.	171.	171.
171.	171.	171.	171.	171.	171.	171.	171.	171.	172.
173.	175.	179.	185.	196.	211.	233.	264.	311.	383.
493.	657.	882.	1352.	1981.	2687.	3651.	4616.	5904.	7246.
8413.	10164.	11736.	12986.	13954.	14675.	15183.	15508.	15676.	15712.
15637.	15469.	15225.	14919.	14563.	14168.	13742.	13293.	12829.	12354.
11874.	11393.	10914.	10440.	9974.	9517.	9071.	8637.	8404.	8187.
7972.	7759.	7548.	7339.	7133.	6930.	6731.	6535.	6343.	6155.

STOR

1600.	1600.	1600.	1600.	1600.	1600.	1600.	1600.	1600.	1600.
1600.	1600.	1600.	1600.	1600.	1600.	1600.	1600.	1600.	1600.
1600.	1600.	1600.	1600.	1600.	1600.	1601.	1602.	1606.	1611.
1620.	1638.	1673.	1734.	1832.	1976.	2181.	2477.	2916.	3587.
4622.	6152.	8259.	10957.	14179.	17792.	21609.	25428.	29047.	32305.
35139.	37524.	39463.	41005.	42198.	43088.	43714.	44114.	44321.	44365.
44272.	44066.	43765.	43388.	42949.	42461.	41936.	41383.	40810.	40225.
39633.	39040.	38449.	37865.	37290.	36727.	36177.	35642.	35116.	34591.
34069.	33550.	33037.	32530.	32030.	31538.	31053.	30578.	30113.	29655.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	15712.	15538.	13433.	6651.	481964.
INCHES		1.18	4.10	6.09	6.12
AC-FT		7709.	26657.	39598.	39852.

STATION 1, PLAN 1, RTIO 8

195.	195.	195.	195.	195.	195.	195.	195.	195.	195.
195.	195.	195.	195.	195.	195.	195.	195.	195.	195.
195.	195.	195.	195.	195.	195.	195.	195.	196.	197.
198.	200.	204.	212.	223.	241.	266.	302.	356.	438.
564.	750.	1055.	1656.	2373.	3320.	4418.	5874.	7553.	9488.
11995.	14044.	15684.	17286.	18498.	19342.	19872.	20137.	20182.	20047.
19763.	19361.	18865.	18296.	17672.	17008.	16317.	15656.	15095.	14525.
13950.	13375.	12805.	12242.	11689.	11148.	10620.	10108.	9612.	9133.
8671.	8409.	8183.	7959.	7738.	7520.	7306.	7095.	6888.	6685.

STOR

1829.	1829.	1829.	1829.	1829.	1829.	1829.	1829.	1829.	1829.
1829.	1829.	1829.	1829.	1829.	1829.	1829.	1829.	1829.	1829.
1829.	1829.	1829.	1829.	1829.	1829.	1830.	1831.	1835.	1841.
1852.	1872.	1912.	1982.	2093.	2258.	2492.	2831.	3333.	4100.
5282.	7030.	9437.	12514.	16187.	20302.	24643.	28972.	33051.	36692.
39782.	42309.	44331.	45898.	47055.	47860.	48366.	48619.	48662.	48532.

48262.	47878.	47405.	46862.	46266.	45633.	44973.	44297.	43605.	42901.
42193.	41484.	40781.	40087.	39405.	38737.	38087.	37456.	36844.	36253.
35684.	35129.	34580.	34036.	33499.	32970.	32449.	31938.	31436.	30943.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	20182.	19894.	16751.	8095.	586326.
INCHES		1.52	5.11	7.41	7.45
AC-FT		9870.	33241.	48191.	48482.

STATION 1, PLAN 1, RTIO 9

244.	244.	244.	244.	244.	244.	244.	244.	244.	244.
244.	244.	244.	244.	244.	244.	244.	244.	244.	244.
244.	244.	244.	244.	244.	244.	244.	244.	245.	246.
247.	250.	255.	264.	279.	301.	333.	378.	445.	547.
705.	938.	1514.	2262.	3292.	4584.	6571.	8903.	12870.	16431.
20061.	22919.	25098.	26952.	28204.	28943.	29254.	29214.	28888.	28335.
27604.	26735.	25765.	24784.	23845.	22869.	21872.	20866.	19861.	18865.
17887.	16930.	16000.	15257.	14569.	13895.	13239.	12601.	11983.	11386.
10811.	10257.	9726.	9217.	8729.	8427.	8192.	7960.	7732.	7507.

STOR

2286.	2286.	2286.	2286.	2286.	2286.	2286.	2286.	2286.	2286.
2286.	2286.	2286.	2286.	2286.	2286.	2286.	2286.	2286.	2286.
2286.	2286.	2286.	2286.	2236.	2286.	2287.	2289.	2294.	2301.
2314.	2340.	2390.	2477.	2617.	2823.	3115.	3538.	4166.	5125.
6603.	8788.	11789.	15618.	20188.	25300.	30666.	35970.	40861.	45082.
48547.	51274.	53353.	54864.	55879.	56479.	56731.	56698.	56434.	55986.
55392.	54688.	53901.	53053.	52157.	51226.	50274.	49314.	48355.	47405.
46471.	45558.	44671.	43805.	42956.	42126.	41316.	40530.	39768.	39032.
38322.	37640.	36985.	36357.	35755.	35173.	34601.	34038.	33484.	32939.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	29254.	28806.	23674.	11077.	801929.
INCHES		2.20	7.22	10.14	10.19
AC-FT		14291.	46981.	65946.	66309.

********** ********** ********** ********** **********

PEAK FLOW SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

			RATIOS APPLIED TO FLOWS								
PERATION	STATION	PLAN	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	1.00
HYDROGRAPH AT	1	1	7204.	14408.	21611.	28815.	36019.	43223.	50426.	57630.	72038.
		2	0.	0.	0.	0.	0.	0.	0.	0.	0.
TED TO	1	1	838.	2163.	3750.	5698.	8150.	11909.	15712.	20182.	29254.
		2	0.	0.	0.	0.	0.	0.	0.	0.	0.

PDATED AUG 79
CHANGE NO. 01
****

INDIAN LAKE DAM
RESERVOIR ROUTING OF P.M.F. - SNYDER METHOD
UNCONTROLLED SPILLWAY ONLY

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
90	1	0	0	0	0	0	0	0	0

JOPER	NWT
5	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN# 1 NRTIO# 9 LRTIO# 1
RTIOS# 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	0	0	0	0	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	122.00	0.0	122.00	0.0	0.0	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	17.50	89.00	101.00	112.00	118.00	0.0	0.0

RSPC COMPUTED BY THE PROGRAM IS 0.872

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	1.00	0.10	0.0	0.0

UNIT HYDROGRAPH DATA
TP# 11.50 CP#0.63 NTA# 0

RECESSION DATA
STRTQ# 244.00 QRCSN# 244.00 RTIOR# 1.00
PPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC#12.82 AND R#10.48 INTERVALS

UNIT HYDROGRAPH 63 END-OF-PERIOD ORDINATES, LAG# 11.43 HOURS, CP# 0.63 VOL# 1.00

110.	412.	838.	1332.	1871.	2440.	3016.	3534.	3938.	4225.
4393.	4434.	4302.	3993.	3629.	3299.	2998.	2725.	2477.	2251.
2046.	1860.	1691.	1537.	1397.	1270.	1154.	1049.	953.	866.
788.	716.	651.	591.	538.	489.	444.	404.	367.	333.
303.	275.	250.	228.	207.	188.	171.	155.	141.	128.

45. 41. 37.

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.01	0.00	244.
2	0.01	0.00	244.
3	0.01	0.00	244.
4	0.01	0.00	244.
5	0.01	0.00	244.
6	0.01	0.00	244.
7	0.02	0.00	244.
8	0.02	0.00	244.
9	0.02	0.00	244.
10	0.02	0.00	244.
11	0.02	0.00	244.
12	0.02	0.00	244.
13	0.07	0.00	244.
14	0.09	0.00	244.
15	0.11	0.00	244.
16	0.28	0.00	244.
17	0.10	0.00	244.
18	0.08	0.00	244.
19	0.01	0.00	244.
20	0.01	0.00	244.
21	0.01	0.00	244.
22	0.01	0.00	244.
23	0.01	0.00	244.
24	0.01	0.00	244.
25	0.11	0.00	244.
26	0.11	0.01	246.
27	0.11	0.01	253.
28	0.11	0.01	264.
29	0.11	0.01	281.
30	0.11	0.01	305.
31	0.31	0.21	357.
32	0.31	0.21	474.
33	0.31	0.21	679.
34	0.31	0.21	984.
35	0.31	0.21	1396.
36	0.31	0.21	1919.
37	1.36	1.26	2671.
38	1.63	1.53	3867.
39	2.04	1.94	5713.
40	5.16	5.06	8714.
41	1.90	1.80	13201.
42	1.49	1.39	18939.
43	0.17	0.07	25516.
44	0.17	0.07	32463.
45	0.17	0.07	39390.
46	0.17	0.07	45947.
47	0.17	0.07	51655.
48	0.17	0.07	56100.
49	0.0	0.0	59033.
50	0.0	0.0	60297.
51	0.0	0.0	59897.
52	0.0	0.0	57859.
53	0.0	0.0	54421.
54	0.0	0.0	50282.
55	0.0	0.0	46073.
56	0.0	0.0	42083.
57	0.0	0.0	38408.
58	0.0	0.0	35024.
59	0.0	0.0	31910.
60	0.0	0.0	29050.
61	0.0	0.0	26422.

63	0.0	0.0	21800.
64	0.0	0.0	19909.
65	0.0	0.0	18119.
66	0.0	0.0	16491.
67	0.0	0.0	15011.
68	0.0	0.0	13666.
69	0.0	0.0	12444.
70	0.0	0.0	11333.
71	0.0	0.0	10323.
72	0.0	0.0	9405.
73	0.0	0.0	8571.
74	0.0	0.0	7812.
75	0.0	0.0	7123.
76	0.0	0.0	6497.
77	0.0	0.0	5927.
78	0.0	0.0	5410.
79	0.0	0.0	4939.
80	0.0	0.0	4512.
81	0.0	0.0	4123.
82	0.0	0.0	3770.
83	0.0	0.0	3449.
84	0.0	0.0	3157.
85	0.0	0.0	2892.
86	0.0	0.0	2650.
87	0.0	0.0	2431.
88	0.0	0.0	2232.
89	0.0	0.0	2051.
90	0.0	0.0	1886.
SUM	18.09	14.71	1160265.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	60297.	57934.	39364.	16054.	1160250.
INCHES		4.42	12.01	14.69	14.74
AC-FT		28743.	78117.	95575.	95938.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	25.	25.	26.	28.	31.
36.	47.	68.	98.	140.	192.	267.	387.	571.	871.
1320.	1894.	2552.	3246.	3939.	4595.	5165.	5610.	5903.	6030.
5990.	5786.	5442.	5028.	4607.	4208.	3841.	3502.	3191.	2905.
2643.	2405.	2188.	1991.	1812.	1649.	1501.	1367.	1244.	1133.
1032.	941.	857.	781.	712.	650.	593.	541.	494.	451.
412.	377.	345.	316.	289.	265.	243.	223.	205.	189.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6030.	5793.	3936.	1605.	116025.
INCHES		0.44	1.20	1.47	1.47
AC-FT		2874.	7812.	9557.	9594.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

49.	49.	49.	49.	49.	49.	49.	49.	49.	49.
49.	49.	49.	49.	49.	49.	49.	49.	49.	49.
49.	49.	49.	49.	49.	49.	51.	53.	56.	61.
71.	95.	136.	197.	279.	384.	534.	773.	1143.	1743.
2640.	3788.	5103.	6493.	7878.	9189.	10331.	11220.	11807.	12059.
11979.	11572.	10884.	10056.	9214.	8417.	7682.	7005.	6382.	5810.
5287.	4810.	4376.	3982.	3624.	3298.	3002.	2733.	2489.	2267.
2065.	1881.	1714.	1562.	1425.	1299.	1185.	1082.	988.	902.
825.	754.	690.	631.	578.	530.	486.	446.	410.	377.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	12059	11587	7873	3211	232051

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
AC-FT		5749.	15623.	19115.	19188.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

73.	73.	73.	73.	73.	73.	73.	73.	73.	73.
73.	73.	73.	73.	73.	73.	73.	73.	73.	73.
73.	73.	73.	73.	73.	74.	76.	79.	84.	92.
107.	142.	204.	295.	419.	576.	801.	1160.	1714.	2614.
3960.	5682.	7655.	9739.	11817.	13784.	15496.	16830.	17710.	18089.
17969.	17358.	16326.	15085.	13822.	12625.	11522.	10507.	9573.	8715.
7930.	7214.	6564.	5973.	5436.	4947.	4503.	4100.	3733.	3400.
3097.	2822.	2571.	2344.	2137.	1949.	1778.	1623.	1482.	1353.
1237.	1131.	1035.	947.	867.	795.	729.	670.	615.	566.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	18089.	17380.	11809.	4816.	348077.
INCHES		1.33	3.60	4.41	4.42
AC-FT		8623.	23435.	28673.	28782.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

98.	98.	98.	98.	98.	98.	98.	98.	98.	98.
98.	98.	98.	98.	98.	98.	98.	98.	98.	98.
98.	98.	98.	98.	98.	99.	101.	106.	113.	122.
143.	190.	272.	393.	558.	768.	1068.	1547.	2285.	3486.
5281.	7576.	10207.	12985.	15756.	18379.	20662.	22440.	23613.	24119.
23959.	23144.	21768.	20113.	18429.	16833.	15363.	14010.	12764.	11620.
10573.	9619.	8752.	7964.	7247.	6596.	6004.	5466.	4978.	4533.
4129.	3762.	3428.	3125.	2849.	2599.	2371.	2164.	1976.	1805.
1649.	1508.	1379.	1263.	1157.	1060.	972.	893.	820.	754.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	24119.	23174.	15746.	6421.	464103.
INCHES		1.77	4.80	5.88	5.90
AC-FT		11497.	31247.	38230.	38375.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

122.	122.	122.	122.	122.	122.	122.	122.	122.	122.
122.	122.	122.	122.	122.	122.	122.	122.	122.	122.
122.	122.	122.	122.	122.	123.	126.	132.	141.	153.
178.	237.	339.	492.	698.	960.	1335.	1934.	2857.	4357.
6601.	9469.	12758.	16231.	19695.	22973.	25827.	28050.	29516.	30148.
29948.	28929.	27210.	25141.	23036.	21042.	19204.	17512.	15955.	14525.
13216.	12024.	10940.	9955.	9059.	8245.	7506.	6833.	6222.	5666.
5161.	4703.	4285.	3906.	3562.	3248.	2964.	2705.	2470.	2256.
2061.	1885.	1724.	1578.	1446.	1325.	1216.	1116.	1025.	943.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	30148.	28967.	19682.	8027.	580129.
INCHES		2.21	6.00	7.34	7.37
AC-FT		14371.	39059.	47788.	47969.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 6

146.	146.	146.	146.	146.	146.	146.	146.	146.	146.
146.	146.	146.	146.	146.	146.	146.	146.	146.	146.
146.	146.	146.	146.	147.	148.	152.	158.	169.	183.
214.	284.	407.	590.	838.	1152.	1602.	2320.	3428.	5228.
7921.	11363.	15310.	19478.	23634.	27568.	30993.	33660.	35420.	36178.
35938.	34715.	32653.	30169.	27643.	25250.	23045.	21014.	19146.	17430.
15860.	14429.	13128.	11946.	10871.	9894.	9007.	8200.	7466.	6800.
6194.	5643.	5142.	4687.	4274.	3898.	3556.	3246.	2964.	2707.
2474.	2262.	2069.	1894.	1735.	1590.	1459.	1339.	1230.	1131.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	36178.	34761.	23618.	9632.	696155.
INCHES		2.65	7.20	8.81	8.85
AC-FT		17246.	46870.	57345.	57563.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 7

171.	171.	171.	171.	171.	171.	171.	171.	171.	171.
171.	171.	171.	171.	171.	171.	171.	171.	171.	171.
171.	171.	171.	171.	171.	173.	177.	185.	197.	214.
250.	332.	475.	689.	977.	1344.	1869.	2707.	3999.	6100.
9241.	13257.	17861.	22724.	27573.	32163.	36158.	39270.	41323.	42200.
41928.	40501.	38095.	35197.	32251.	29458.	26886.	24517.	22337.	20335.
18503.	16833.	15316.	13937.	12683.	11543.	10508.	9566.	8711.	7933.
7226.	6584.	6000.	5469.	4986.	4548.	4149.	3787.	3457.	3158.
2886.	2639.	2414.	2210.	2024.	1855.	1702.	1562.	1435.	1320.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	42200.	40554.	27555.	11238.	812180.
INCHES		3.09	8.40	10.28	10.32
AC-FT		20120.	54682.	66903.	67157.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 8

195.	195.	195.	195.	195.	195.	195.	195.	195.	195.
195.	195.	195.	195.	195.	195.	195.	195.	195.	195.
195.	195.	195.	195.	195.	197.	202.	211.	225.	244.
286.	379.	543.	787.	1117.	1536.	2136.	3094.	4571.	6971.
10561.	15151.	20413.	25970.	31512.	36757.	41324.	44880.	47226.	48237.
47918.	46287.	43537.	40226.	36858.	33666.	30726.	28019.	25528.	23240.
21146.	19238.	17504.	15927.	14495.	13192.	12009.	10933.	9955.	9066.
8258.	7524.	6857.	6250.	5699.	5197.	4742.	4328.	3951.	3609.
3298.	3016.	2759.	2525.	2313.	2120.	1945.	1786.	1640.	1500.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	48237.	46347.	31491.	12843.	928206.
INCHES		3.53	9.60	11.75	11.80
AC-FT		22994.	62494.	76460.	76751.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 9

244.	244.	244.	244.	244.	244.	244.	244.	244.	244.
244.	244.	244.	244.	244.	244.	244.	244.	244.	244.
244.	244.	244.	244.	244.	246.	253.	264.	281.	305.
357.	474.	679.	984.	1396.	1919.	2671.	3867.	5713.	8714.
13201.	18939.	25516.	32463.	39390.	45947.	51655.	56100.	59033.	60297.
59897.	57859.	54421.	50282.	46072.	42083.	38408.	35024.	31910.	29050.
26433.	24048.	21880.	19909.	18118.	16491.	15011.	13666.	12444.	11333.
10323.	9405.	8571.	7812.	7123.	6497.	5927.	5410.	4939.	4512.
4123.	3770.	3449.	3157.	2892.	2650.	2431.	2232.	2051.	1886.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	60297.	57934.	39364.	16054.	1160246.
INCHES		4.42	12.01	14.69	14.74
AC-FT		28742.	78117.	95574.	95938.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	1	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.0	0.0	0.0	-1.

STORAGE=	0.	8900.	17800.	26700.	35600.	44500.	53400.	62300.	66750.	0.
OUTFLOW=	0.	950.	2680.	4930.	8603.	15821.	25147.	36120.	42147.	0.

24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.	24.	24.
25.	25.	25.	26.	26.	28.	29.	32.	36.	42.
51.	65.	84.	108.	139.	175.	217.	262.	310.	360.
410.	458.	503.	545.	582.	616.	646.	672.	696.	716.
734.	750.	764.	775.	785.	794.	800.	806.	810.	814.
816.	818.	818.	818.	818.	816.	815.	813.	810.	807.
804.	800.	796.	792.	788.	783.	779.	774.	769.	764.

STOR

229.	229.	229.	229.	229.	229.	229.	229.	229.	229.
229.	229.	229.	229.	229.	229.	229.	229.	229.	229.
229.	229.	229.	229.	229.	229.	229.	229.	229.	229.
230.	232.	234.	239.	247.	258.	275.	299.	336.	392.
479.	607.	785.	1016.	1303.	1643.	2030.	2455.	2907.	3373.
3838.	4288.	4713.	5102.	5454.	5768.	6049.	6298.	6518.	6711.
6881.	7028.	7155.	7264.	7357.	7435.	7499.	7551.	7592.	7623.
7645.	7660.	7666.	7666.	7660.	7649.	7633.	7613.	7588.	7561.
7530.	7496.	7460.	7422.	7381.	7339.	7296.	7251.	7205.	7158.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	818.	817.	803.	445.	32471.
INCHES		0.06	0.24	0.41	0.41
AC-FT		406.	1594.	2649.	2685.

STATION 1, PLAN 1, RTIO 2

49.	49.	49.	49.	49.	49.	49.	49.	49.	49.
49.	49.	49.	49.	49.	49.	49.	49.	49.	49.
49.	49.	49.	49.	49.	49.	49.	49.	49.	49.
49.	49.	50.	51.	53.	55.	59.	64.	72.	84.
102.	130.	168.	217.	278.	351.	433.	524.	621.	720.
819.	916.	1052.	1203.	1338.	1458.	1563.	1656.	1736.	1806.
1866.	1917.	1960.	1995.	2024.	2047.	2065.	2078.	2086.	2091.
2092.	2090.	2086.	2078.	2069.	2058.	2045.	2030.	2014.	1997.
1979.	1960.	1940.	1920.	1899.	1877.	1855.	1833.	1810.	1788.

STOR

457.	457.	457.	457.	457.	457.	457.	457.	457.	457.
457.	457.	457.	457.	457.	457.	457.	457.	457.	457.
457.	457.	457.	457.	457.	457.	457.	458.	458.	459.
460.	463.	468.	478.	493.	516.	550.	599.	672.	785.
958.	1214.	1569.	2033.	2606.	3285.	4060.	4911.	5815.	6746.
7675.	8577.	9423.	10196.	10887.	11500.	12040.	12514.	12927.	13285.
13591.	13852.	14072.	14253.	14402.	14519.	14610.	14676.	14719.	14743.
14749.	14739.	14715.	14679.	14631.	14573.	14506.	14431.	14350.	14262.
14169.	14072.	13970.	13865.	13757.	13647.	13535.	13421.	13306.	13190.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2092.	2087.	2022.	1081.	78691.
INCHES		0.16	0.62	0.99	1.00
AC-FT		1036.	4012.	6434.	6507.

STATION 1, PLAN 1, RTIO 3

73.	73.	73.	73.	73.	73.	73.	73.	73.	73.
73.	73.	73.	73.	73.	73.	73.	73.	73.	73.
73.	73.	73.	73.	73.	73.	73.	73.	73.	73.
74.	74.	75.	77.	79.	83.	88.	96.	108.	126.
153.	194.	251.	325.	417.	526.	650.	786.	931.	1187.
1457.	1716.	1958.	2178.	2375.	2549.	2705.	2877.	3025.	3151.
3258.	3348.	3421.	3480.	3526.	3560.	3584.	3599.	3606.	3605.
3597.	3584.	3566.	3543.	3516.	3485.	3452.	3416.	3377.	3337.
3294.	3251.	3206.	3160.	3114.	3066.	3019.	2971.	2923.	2874.

STOR

686.	686.	686.	686.	686.	686.	686.	686.	686.	686.
686.	686.	686.	686.	686.	686.	686.	686.	687.	688.
690.	695.	703.	717.	740.	774.	824.	898.	1008.	1177.
1437.	1822.	2354.	3049.	3909.	4928.	6089.	7366.	8722.	10114.
11495.	12823.	14063.	15190.	16197.	17086.	17867.	18547.	19132.	19633.
20056.	20409.	20698.	20931.	21113.	21249.	21345.	21403.	21429.	21426.
21397.	21345.	21272.	21182.	21075.	20955.	20822.	20679.	20526.	20366.
20199.	20026.	19849.	19668.	19484.	19297.	19108.	18919.	18728.	18537.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3606.	3596.	3449.	1832.	133224.
INCHES		0.27	1.05	1.68	1.69
AC-FT		1784.	6844.	10907.	11016.

STATION 1, PLAN 1, RTIO 4

98.	98.	98.	98.	98.	98.	98.	98.	98.	98.
98.	98.	98.	98.	98.	98.	98.	98.	98.	98.
98.	98.	98.	98.	98.	98.	98.	98.	98.	98.
98.	99.	100.	102.	105.	110.	117.	128.	143.	168.
205.	259.	335.	434.	556.	701.	867.	1129.	1480.	1838.
2194.	2536.	2903.	3276.	3607.	3897.	4149.	4367.	4553.	4711.
4843.	4961.	5102.	5211.	5291.	5346.	5378.	5390.	5384.	5363.
5328.	5282.	5226.	5160.	5088.	5009.	4929.	4874.	4816.	4756.
4693.	4629.	4563.	4496.	4428.	4359.	4290.	4221.	4151.	4082.

STOR

914.	914.	914.	914.	914.	914.	914.	914.	914.	914.
914.	914.	914.	914.	914.	914.	914.	914.	914.	914.
914.	914.	914.	914.	914.	914.	915.	915.	916.	918.
920.	926.	937.	956.	987.	1033.	1099.	1197.	1344.	1570.
1917.	2429.	3139.	4066.	5212.	6571.	8119.	9818.	11613.	13448.
15268.	17019.	18650.	20126.	21434.	22581.	23579.	24441.	25179.	25803.
26326.	26755.	27098.	27363.	27557.	27690.	27767.	27796.	27783.	27732.
27648.	27536.	27398.	27240.	27063.	26871.	26666.	26448.	26219.	25980.
25732.	25477.	25217.	24951.	24683.	24411.	24138.	23863.	23588.	23313.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5390.	5365.	5055.	2680.	194744.
INCHES		0.41	1.54	2.45	2.47
AC-FT		2662.	10033.	15958.	16103.

STATION 1, PLAN 1, RTIO 5

122.	122.	122.	122.	122.	122.	122.	122.	122.	122.
122.	122.	122.	122.	122.	122.	122.	122.	122.	122.
122.	122.	122.	122.	122.	122.	122.	122.	122.	122.
123.	124.	125.	128.	132.	138.	147.	160.	179.	209.
256.	324.	419.	542.	695.	877.	1193.	1605.	2040.	2485.
2996.	3543.	4050.	4508.	4912.	5470.	5960.	6375.	6722.	7007.
7236.	7416.	7552.	7649.	7711.	7743.	7747.	7728.	7688.	7630.
7555.	7468.	7368.	7259.	7141.	7016.	6885.	6749.	6610.	6468.
6324.	6178.	6032.	5885.	5739.	5593.	5448.	5305.	5163.	5024.

STOR

1143.	1143.	1143.	1143.	1143.	1143.	1143.	1143.	1143.	1143.
1143.	1143.	1143.	1143.	1143.	1143.	1143.	1143.	1143.	1143.
1143.	1143.	1143.	1143.	1143.	1143.	1143.	1144.	1145.	1147.
1151.	1158.	1171.	1195.	1233.	1291.	1374.	1496.	1680.	1962.
2396.	3036.	3924.	5082.	6515.	8213.	10145.	12255.	14483.	16762.
19019.	21181.	23187.	24997.	26599.	27991.	29182.	30189.	31031.	31723.
32281.	32719.	33049.	33284.	33435.	33512.	33522.	33475.	33378.	33236.
33056.	32843.	32601.	32335.	32049.	31745.	31428.	31098.	30760.	30415.
30065.	29711.	29356.	29000.	28645.	28291.	27940.	27591.	27247.	26908.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7747.	7711.	7210.	3725.	270412.

AC-FT	3826.	14309.	22178.	22360.

STATION 1, PLAN 1, RTIO 6

146.	146.	146.	146.	146.	146.	146.	146.	146.	146.
146.	146.	146.	146.	146.	146.	146.	146.	146.	146.
146.	146.	146.	146.	146.	146.	146.	147.	147.	147.
147.	148.	150.	153.	158.	165.	176.	192.	215.	251.
307.	389.	503.	651.	835.	1136.	1587.	2079.	2598.	3259.
3937.	4586.	5342.	6215.	6974.	7626.	8178.	8678.	9418.	9993.
10424.	10731.	10928.	11032.	11057.	11013.	10912.	10762.	10572.	10349.
10099.	9828.	9540.	9240.	8932.	8618.	8447.	8278.	8105.	7929.
7750.	7570.	7389.	7208.	7027.	6848.	6670.	6493.	6319.	6147.

STOR

1372.	1372.	1372.	1372.	1372.	1372.	1372.	1372.	1372.	1372.
1372.	1372.	1372.	1372.	1372.	1372.	1372.	1372.	1372.	1372.
1372.	1372.	1372.	1372.	1372.	1372.	1372.	1373.	1374.	1376.
1381.	1389.	1405.	1434.	1480.	1549.	1649.	1796.	2016.	2355.
2875.	3643.	4708.	6098.	7818.	9853.	12160.	14680.	17341.	20058.
22741.	25308.	27682.	29800.	31644.	33226.	34569.	35693.	36605.	37314.
37846.	38223.	38467.	38596.	38626.	38572.	38447.	38262.	38028.	37753.
37445.	37111.	36756.	36386.	36005.	35618.	35221.	34811.	34390.	33962.
33528.	33091.	32652.	32212.	31774.	31338.	30905.	30477.	30054.	29636.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	11057.	10951.	9711.	4917.	356656.
INCHES		0.83	2.96	4.50	4.53
AC-FT		5433.	19271.	29273.	29491.

STATION 1, PLAN 1, RTIO 7

171.	171.	171.	171.	171.	171.	171.	171.	171.	171.
171.	171.	171.	171.	171.	171.	171.	171.	171.	171.
171.	171.	171.	171.	171.	171.	171.	171.	171.	171.
172.	173.	175.	179.	184.	193.	205.	224.	251.	293.
358.	454.	586.	759.	993.	1455.	1979.	2551.	3292.	4087.
4872.	6048.	7161.	8147.	9379.	10772.	11900.	12795.	13485.	13994.
14346.	14561.	14659.	14657.	14570.	14410.	14191.	13921.	13611.	13268.
12899.	12511.	12107.	11694.	11275.	10852.	10431.	10012.	9597.	9189.
8789.	8497.	8298.	8097.	7897.	7698.	7500.	7303.	7109.	6917.

STOR

1600.	1600.	1600.	1600.	1600.	1600.	1600.	1600.	1600.	1600.
1600.	1600.	1600.	1600.	1600.	1600.	1600.	1600.	1600.	1600.
1600.	1600.	1600.	1600.	1600.	1600.	1601.	1601.	1603.	1606.
1611.	1621.	1639.	1673.	1727.	1807.	1923.	2095.	2352.	2747.
3354.	4250.	5493.	7115.	9121.	11488.	14169.	17099.	20188.	23334.
26441.	29396.	32098.	34494.	36557.	38274.	39665.	40769.	41619.	42247.
42681.	42946.	43067.	43065.	42957.	42761.	42490.	42158.	41775.	41352.
40897.	40418.	39921.	39411.	38894.	38374.	37854.	37337.	36826.	36323.
35830.	35344.	34858.	34372.	33886.	33402.	32921.	32444.	31972.	31507.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	14659.	14534.	12771.	6250.	453107.
INCHES		1.11	3.90	5.72	5.76
AC-FT		7211.	25345.	37212.	37466.

STATION 1, PLAN 1, RTIO 8

195.	195.	195.	195.	195.	195.	195.	195.	195.	195.
195.	195.	195.	195.	195.	195.	195.	195.	195.	195.
195.	195.	195.	195.	195.	195.	195.	195.	196.	196.
196.	198.	200.	204.	211.	220.	235.	256.	287.	335.
409.	518.	670.	868.	1247.	1773.	2370.	3119.	4007.	4911.
6339.	7703.	9272.	11387.	13148.	14582.	15724.	16830.	17655.	18214.
18544.	18681.	18655.	18494.	18222.	17858.	17422.	16928.	16390.	15819.
15355.	14871.	14373.	13866.	13354.	12841.	12331.	11825.	11327.	10837.

STOR

1829.	1829.	1829.	1829.	1829.	1829.	1829.	1829.	1829.	1829.
1829.	1829.	1829.	1829.	1829.	1829.	1829.	1829.	1829.	1829.
1829.	1829.	1829.	1829.	1829.	1829.	1829.	1830.	1832.	1835.
1841.	1852.	1874.	1912.	1973.	2065.	2198.	2394.	2688.	3140.
3833.	4857.	6278.	8131.	10419.	13115.	16170.	19506.	23017.	26594.
30102.	33415.	36425.	39032.	41204.	42972.	44381.	45463.	46251.	46784.
47099.	47229.	47205.	47051.	46791.	46444.	46028.	45556.	45043.	44498.
43925.	43329.	42714.	42089.	41458.	40826.	40196.	39573.	38958.	38355.
37765.	37189.	36629.	36085.	35559.	35041.	34526.	34014.	33507.	33006.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	18681.	18468.	15916.	7645.	553968.
INCHES		1.41	4.85	7.00	7.04
AC-FT		9163.	31585.	45515.	45806.

STATION 1, PLAN 1, RTIO 9

244.	244.	244.	244.	244.	244.	244.	244.	244.	244.
244.	244.	244.	244.	244.	244.	244.	244.	244.	244.
244.	244.	244.	244.	244.	244.	244.	244.	244.	245.
246.	247.	250.	255.	263.	276.	293.	319.	359.	419.
511.	648.	838.	1196.	1752.	2407.	3284.	4330.	5736.	7541.
9953.	13126.	15942.	18964.	21389.	23272.	24681.	25770.	26516.	26900.
26982.	26813.	26440.	25902.	25234.	24563.	23832.	23044.	22215.	21358.
20484.	19602.	18721.	17847.	16985.	16141.	15427.	14794.	14170.	13558.
12958.	12374.	11806.	11254.	10720.	10205.	9708.	9229.	8770.	8461.

STOR

2286.	2286.	2286.	2286.	2286.	2286.	2286.	2286.	2286.	2286.
2286.	2286.	2286.	2286.	2286.	2286.	2286.	2286.	2286.	2286.
2286.	2286.	2286.	2286.	2286.	2286.	2286.	2288.	2290.	2294.
2301.	2315.	2342.	2390.	2467.	2582.	2748.	[illegible]	3360.	3924.
4792.	6072.	7847.	10159.	13007.	16361.	20159.	24297.	28638.	33021.
37265.	41177.	44615.	47499.	49814.	51611.	52955.	53905.	54510.	54822.
54888.	54751.	54448.	54012.	53471.	52843.	52145.	51393.	50602.	49784.
48950.	48108.	47268.	46433.	45611.	44805.	44014.	43234.	42465.	41709.
40970.	40250.	39549.	38869.	38211.	37575.	36962.	36372.	35806.	35256.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	26982.	26592.	22483.	10558.	764602.
INCHES		2.03	6.86	9.66	9.72
AC-FT		13193.	44618.	62860.	63223.

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PEAK FLOW SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

			RATIOS APPLIED TO FLOWS								
PERATION	STATION	PLAN	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	1.00
HYDROGRAPH AT	1	1	6030.	12059.	18089.	24119.	30148.	36178.	42208.	48237.	60297.
		2	0.	0.	0.	0.	0.	0.	0.	0.	0.
UTED TO	1	1	818.	2092.	3606.	5390.	7747.	11057.	14659.	18681.	26982.
		2	0.	0.	0.	0.	0.	0.	0.	0.	0.

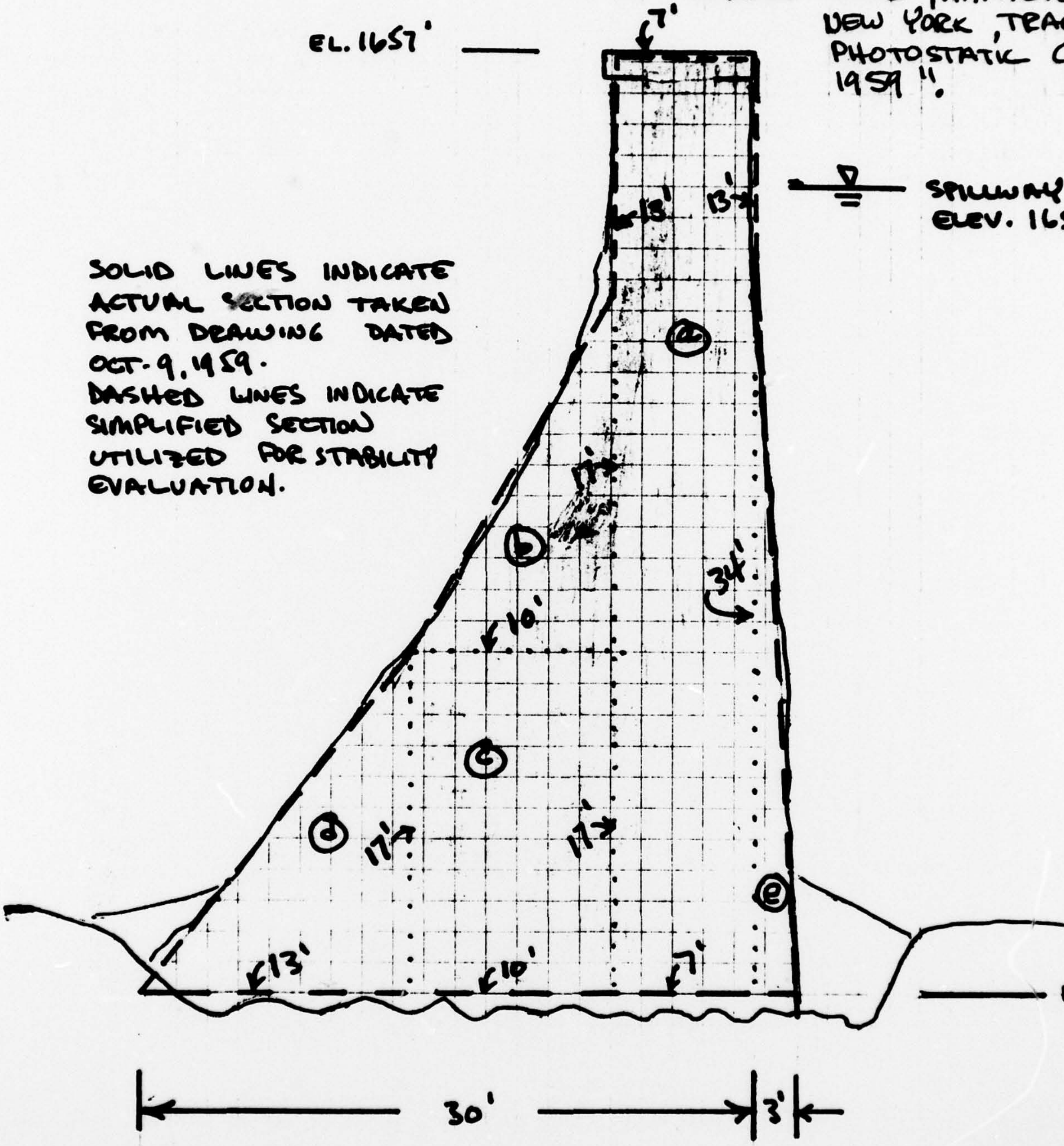
APPENDIX D

STABILITY ANALYSIS

INDIAN RIVER/LAKE DAM

TYPICAL SECTION TAKEN FROM DRAWING "INTERNATIONAL PAPER COMPANY, HUDSON RIVER MILL, PALMER, N.Y., INDIAN RIVER, TOWN OF INDIAN LAKE, HAMILTON COUNTY, NEW YORK, TRACED FROM PHOTOSTATIC COPY OCT. 9, 1959".

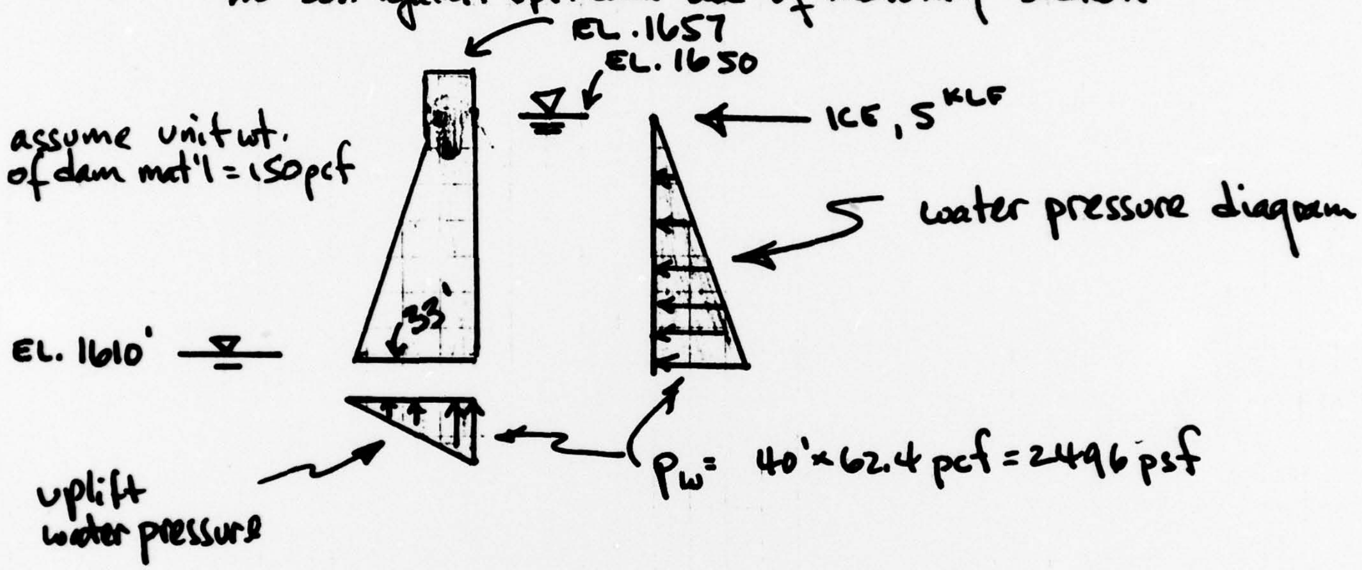
SOLID LINES INDICATE ACTUAL SECTION TAKEN FROM DRAWING DATED OCT. 9, 1959.
DASHED LINES INDICATE SIMPLIFIED SECTION UTILIZED FOR STABILITY EVALUATION.



STABILITY – OVERTURNING & SLIDING

I. Assumed conditions

- WL at spillway elevation (EL. 1650)
- Downstream WL at elev corresponding to base of dam
- Downstream ground surface at base elev.
- Up stream ground surface at base elev.
- Ice acting at spillway elevation (use 5 KLF)
- Uplift acting over 100% of base area, full hydrostatic pressure conditions
- Neglect vertical effect of water pressure on sloping upstream face of dam
- No soil against upstream face of masonry section



A. OVERTURNING

i) Forces causing overturning about toe = horiz. water pressure + + uplift water pressure + ice

$$\text{Moments about toe} = (40\times 62.4)\left(\tfrac{40}{2}\right)\left(\tfrac{40}{3}\right) + (40\times 62.4)\left(\tfrac{33}{2}\right)\left(\tfrac{2}{3}\times 33\right) + (5000\times 40)^3 =$$

$$= 665.6^{1K} + 906^{1K} + 200^{1K} = 1771.6^{1K}$$

(ii) Forces resisting overturning about toe = mass of dam

$$\text{Moment about dam toe} = \overset{a}{(47'\times 7'\times .150)}\left(23+\tfrac{7}{2}\right) + \overset{b}{\left(\tfrac{1}{2}\times 17\times 10\times .150\right)}\left(13+\tfrac{2\times 10}{3}\right) +$$
$$+ \overset{c}{(10\times 17\times .150)}\left(13+\tfrac{10}{2}\right) + \overset{d}{\left(\tfrac{1}{2}\times 13\times 17\times .150\right)}\left(\tfrac{2}{3}\times 13\right) +$$
$$+ \overset{e}{\left(\tfrac{1}{2}\times 3\times 34\times .150\right)}\left(30+\tfrac{3}{3}\right) = 2398.7^{1K}$$

$$\text{FS against overturning} = \frac{2398.7^{1K}}{1771.6^{1K}} = 1.35 \pm \quad (\text{with uplift})$$

B. SLIDING

Forces causing sliding = horiz. water pressure + ice

$= \left(40 \times 62.4 \times \frac{40}{2}\right) + 5{,}000 = 54.9^{k}$

Force resisting sliding = friction at base of dam

= coef. friction [wt. dam − uplift pressure]

where coef. friction μ = 0.65 (assumed),

wt. dam $= (47 \times 7 \times .150) + (\frac{1}{2} \times 17 \times 10) + (10 \times 17 \times .15$

$+ (\frac{1}{2} \times 13 \times 17 \times .150) + (\frac{1}{2} \times 3 \times 34 \times .15$

$= 184^{k}$

uplift $= (40 \times 62.4)(\frac{33}{2}) = 41.2^{k}$

therefore, frictional resistance to sliding $= 0.65[184^{k} - 41.2^{k}] = 93$

FS against sliding $= \frac{93^{k}}{54.9^{k}} = 1.7 \pm$ (if $\mu = 0.65$)

$= 2.1 \pm$ (if $\mu = 0.80$)

II Condition where water level tops main dam section by one foot, no ice.

A. OVERTURNING

Moments about toe causing overturning due to horiz. water pressure and uplift =

$= (48' \times 62.4)(\frac{48}{2})(\frac{48}{3}) + (48 \times 62.4)(\frac{33}{2})(\frac{2}{3} \times 33)$

$= 1150^{\prime k} + 1087^{\prime k} = 2237^{\prime k}$

Moment about toe resisting overturning due to mass of dam $= 2399^{\prime k}$ (from case I)

FS against overturning $= \frac{2399^{\prime k}}{2237^{\prime k}} = 1.1 \pm$

B. SLIDING

Force causing sliding = horiz. water pressure

$= \left(48' \times 62.4 \times \frac{48}{2}\right) = 71.9^{k}$

Force resisting sliding = friction along base of dam

= coef. friction [wt. dam − uplift]

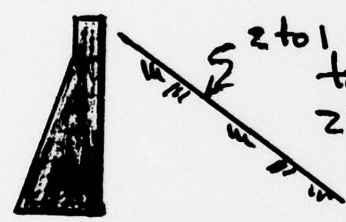
where uplift = $48 \times 62.4 \times \frac{33}{2} = 49.2^{k}$

wt. dam = 184^{k} (case I)

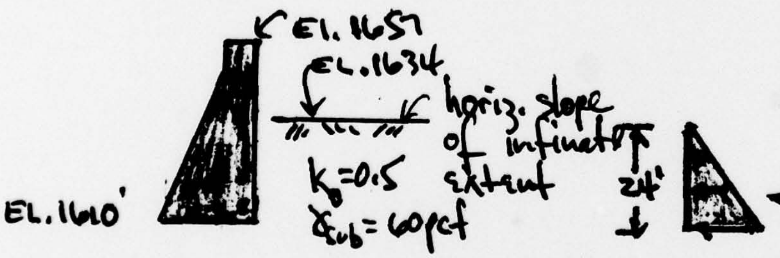
therefore frictional resistance to sliding = $.65\left[184 - 49.2\right] = 87.6$

$$FS \text{ against sliding} = \frac{87.6^{k}}{71.9^{k}} = 1.2 \pm \quad (\text{if } \mu = 0.65)$$
$$= 1.5 \pm \quad (\text{if } \mu = 0.80)$$

III Modify Cases I and II to include a soil pressure from earth mass extending from the embankment section into the area behind the non-overflow masonry section.



2 to 1 slope (H to V) perpendicular to longitudional axis of dam, 2½ to 1 slope parallel to longit. axis of dam



For simplification of evaluation assume a horizontal soil surface behind dam, at mid height of dam. Assumed equivalent earth pressure condition to evaluate effect on stability

$p_{soil} = K_0 \gamma Z$
$= (0.5)(60)(24') = 720$ psf

Overturning moment about toe due to assumed soil pressure $= \frac{1}{2} \times 24' \times 720 \times \frac{24'}{3}$
$= 69^{1k}$

For case I.A (overturning) : $FS = \frac{2398.7^{1k}}{1771.6 + 69} = 1.30 \pm$

case I.B (sliding) : $FS = \frac{93^{k}}{54.9 + 8.6^{k}} = 1.45 \pm$ (if $\mu = .65$) $FS = 1.8$ (if $\mu = 0.8$)

case II.A (overturning): $FS = 2399/2307 = 1.04 \pm$

case II.B (sliding) : $FS = 82.6/80.5 = 1.1 \pm$ (if $\mu = .65$) $FS = 1.35 \pm$ (if $\mu = 0.80$)

APPENDIX E

REFERENCES

APPENDIX

REFERENCES

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